DENISON UNIVERSITY BULLETIN

Volume XXV, No. 6

JOURNAL

OF THE

SCIENTIFIC LABORATORIES

Volume XXI Article 4 Pages 117 to 283

EDITED BY

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Permanent Secretary Denison Scientific Association

GRANVILLE, OHIO

SEPTEMBER, 1925

The University Bulletin is issued bi-monthly and is entered at the Post Office in Granville, Ohio, as mail matter of the Second Class

JOURNAL
OF THE
SCIENTIFIC LABORATORIES
OF
DENISON UNIVERSITY

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THE AGRICULTURAL GEOGRAPHY OF THE SALT LAKE OASIS[1]

CHARLES LANGDON WHITE

Introduction

The Salt Lake Oasis, a well defined geographic unit within the arid West, affords a unique illustration of man's adjustment to natural conditions in his agricultural utilization of the land. The determination of the best use of the land presents a promising field of geographical research. As the population increases and the per capita acreage of land for food production decreases, the burden placed upon each acre is heavier, since the land available for crops is limited, both physically and economically. The physical bases are practically stationary, but the economic conditions fluctuate. To anticipate the needs of the people, a study of the past and present uses of the land, as well as its future possibilities, is necessary. This thesis is such a study; it attempts to analyze the inter-relationships between the elements of the natural environment and man's agricultural utilization of the land to the end that it shall contribute to the economic good of the densely populated Oasis.

The Salt Lake Oasis was chosen for study because it constitutes a geographic unit; because it developed distinctively under the centralized power of the Mormon Church; because it represents the first example of irrigation on a large scale by Anglo-Saxons in America; because it marks the origin and most successful application of American dry-farming methods; because it persists as one of the important farming sections of arid America; and finally because it holds a deep personal charm to the writer, who spent his boyhood days there.

[1] A dissertation submitted to the Graduate Board of Clark University, Worcester, Massachusetts, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

The investigation has been undertaken in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Graduate School of Geography, Clark University. The analysis of the problem is based upon an intensive field investigation carried on during the summer of 1923 and upon an examination of the relevant literature in the John Crerar, University of Chicago, Brigham Young University, Clark University, and the Ogden and Salt Lake City Public Libraries.

The writer wishes to express his appreciation to the several hundred persons whom he personally interviewed for the valuable data which are incorporated in this thesis. He is particularly indebted in this connection to Messrs. F. S. Baker, Ernest Winkler and Aaron Christiansen of the Forest Service, Philip Dix of the Amalgamated Sugar Company, B. N. Christiansen of American Fork and W. A. Cooper of Roy.

The writer has also had the coöperation of the Geography Staff of Clark University, and is especially indebted to Dr. O. E. Baker for helpful criticism and valuable material on the agriculture of the region; to Dr. Clarence F. Jones for his help in the organization and development of the entire thesis; and to Dr. Ellen C. Semple for a careful reading of the completed manuscript and for her pertinent criticisms on geographic analysis and form of expression. Further acknowledgments are made in the bibliography and footnotes.

I. The Mormon Conquest of Utah

Few regions within the arid West offer so attractive a field for a thorough study of agricultural adjustments to environmental conditions as Utah. An understanding of its present development and a forecast of its future can be best appreciated by a careful interpretation of its past. No Western state has quite so interesting and significant an agricultural history as has Utah, the empire of the Mormon pioneers, where irrigation on a large scale was first undertaken by English settlers in America and where modern dry-farming was inaugurated in this continent. The study of early Utah irrigation and dry-farming in relation to the peculiar natural environment, therefore discloses important geographic principles.

The Mormons are unique among the various social groups which poured into the West during the first half of the 19th century. Both in form and ideal their migration was a religious movement, organized for the purpose[2] of acquiring land and establishing homes in a remote and isolated region, where they might be safe from interference, persecution, and contamination. The Mormons made agriculture in Utah the very foundation of settlement; in all other intermontane states the industry was merely an adjunct of mining. The settlers subordinated their industrial activities to the needs of a pioneer religious community and adapted their religious ideals to the various problems in hand. The Mormons are noted for the well-coördinated action which they displayed in taking up the land and in establishing their civic communities, both towns and rural villages.

DEPARTURE OF THE MORMONS

The pioneers departed from Nauvoo, Illinois, and began their journey into the Western wilderness in February 1846. "We sold our farm, with its belongings, for a wagon and a pair of horses this morning and left with the Saints. Whither we are going, I know not, but only trust to God, who doeth all things well," wrote Lorenzo D. Young in his journal. They made their first long stop in January, 1847 at Winter Quarters (now Council Bluffs, Iowa), where they built a town of some 700 log and mud houses. Probably many of the pioneers did not know whither they were going, but it is almost certain that Brigham Young did know. He had seriously considered the migration prior to 1847, the year of their departure. It is claimed that he was but carrying out the plans of Joseph Smith, who early in 1842 said that his

[2] Levi Edgar Young, Professor of Western History, University of Utah, says, "They left their lands and homes in Missouri and Illinois for three principal reasons. First, they were abolitionists and were opposed to the system of labor that had grown up in the South. Second, the 'Mormons' were good farmers and had brought their holdings to the highest point of tillage, which engendered an antagonism toward them on the part of those who were not of their religious faith. Third, the people felt that in some western territory they might work out their religious and civic idealism, which to them was a divine obligation and the will of their God."

people "would yet be driven to the Rocky Mountains, where they would be able to build a city of their own free from all interference." In confirmation of this the following extract from Heber C. Kimball's diary suggests that a migration was contemplated:

> Nauvoo Temple, December 31, 1845,—President Young and myself are superintending the operations of the day, examining maps with reference to selecting a location for the Saints west of the Rocky Mountains, and reading the various works which have been written and published by travellers in those regions.

Probably Captain Fremont's report of his scientific exploration of Utah, which was published in 1845 and which was carefully studied by Young, influenced the Mormons to select the Valley of the Great Salt Lake for their future home.

THE "MORMON TRAIL"

When the pioneers began their journey across the western wilderness, they did not follow the well-known Overland Trail, but marked out a new route which has since been known as the "Mormon Trail." While the two ran parallel on the gentle upward slope from the Missouri River to Fort Laramie on the Platte where they were united, the former bordered the south side of the river, while the latter followed the north bank. This new route, though more difficult and dangerous than the older one, was chosen for two reasons: first, the pioneers wished to avoid their enemies, some of whom they might have met on the Overland Trail, and second, they wished to carry on their religious worship without molestation, for they never traveled on Sunday. Since this new trail was to be used by subsequent emigrants, the van adopted some curious devices for informing their friends about the route. For instance, they used bleached buffalo skulls, which they found on the prairies, as post-offices. They deposited their letters inside and placed the skulls on the ground at the sides of the trail or suspended them from the few available trees. They wrote on the bald fronts of other craniums directions as to their movements and camping places.

From Fort Laramie they followed the Overland Trail, mounting by easy gradients to South Pass (7490 feet), which presented no obstacle to their movements. From here they began the western descent of the Rockies. On June 23, 1847, the Mormons met Jim Bridger, the famous Rocky Mountain trader and trapper, on the Big Sandy River in western Wyoming. He urged them not to settle in the Valley of the Great Salt Lake because they would find it difficult to ripen crops there. He said it would be unwise to bring a large colony into the Great Basin until it was proved that grain could be raised there, and he offered to give a thousand dollars for the first ear of corn that matured in Salt Lake Valley. They received similar advice from all whom they met on the trail west of Fort Laramie, but these opinions failed to convince Young.[3] Later they crossed the Green River and shortly arrived at Fort Bridger, where they set up their forges, shod their animals and repaired their wagons; for they anticipated that from here their journey would be very difficult since their path lay wholly in the mountains. From the fort they moved southwestward along the rugged spurs of the towering snow-capped Uintas, and soon crossed the Bear River. Following the dim wagon road of former immigrants, they descended Echo Canyon, and after surmounting Big Mountain "where wheels were double-locked lest teams and wagons should rush on to destruction," they entered Emigration Canyon. The whole route from Missouri to their destination was characterized by relatively easy gradients which presented no serious difficulty either to the pioneers who crossed in covered wagons or to the push cart immigrants who followed nine years later.

Forage for animals was available most of the way, though occasionally the prairies were burned by Indians, so that the cattle and horses almost perished from hunger. In some places the pioneers felled hundreds of cottonwoods along the bank of the river and supplied their stock with the green boughs for forage. Most of the food for the advance company was brought from their homes in Iowa, but it was supplemented en route by the abundant game of the prairies.

[3] Whitney, Orson F., *History of Utah*, Vol. I (Salt Lake City, 1892), p. 315.

THE FIRST VIEW OF THE VALLEY

On July 24, 1847, after a long and tedious journey, the pioneers descended Emigration Canyon and arrived in the arid valley of the Great Salt Lake (at the western foot of the Wasatch Mountains) near the present site of Salt Lake City. The panorama which stretched out before their eyes was far different from that seen by the observer who today enters that valley. Instead of the picturesquely verdant rectangular fields of alfalfa and sugar beets, the golden squares of grain, the well-kept orchards and gardens, the green pastures grazed by herds of sheep and cattle, and the numerous farm villages, which today characterize the landscape, the hardy pioneers saw only the great gray and red mountains (capped here and there with snow) hemming in the valley, dotted with sagebrush, greasewood, and kindred desert plants. They saw no green spots save narrow strips of herbage along the mountain streams as these spread out upon the plain. Less than half way across the sun-baked valley, they observed a narrow meandering river flowing from south to north. Silence and solitude, the desolation of the desert, encircled them, while over against the western horizon, shimmering in the desert sun, lay America's Dead Sea, Great Salt Lake, dotted with mountain islands.

THE FIRST IRRIGATION

"The transformation of this sterile waste glistening with beds of salt, soda, and deadly alkali seemed impossible." But the Mormons knew that in order to live they must produce food, and produce it by new and untried methods of tillage. However, they were a determined people and lost no time in beginning their task, for the season was already far advanced. Within two hours from the time they arrived at City Creek, they were plowing and they kept it up for the rest of the day. Owing to the extreme dryness of the soil, they found the work very difficult and broke several plows in their effort to cleave the hard earth. They therefore made a dam in the creek, flooded the surrounding soil, and began their task anew. On the following morning, the pioneers dedicated a tract of land to the Lord and began planting,

first putting in potatoes. "Having planted a few acres they turned the water from the creek upon their little field and gave the soil a 'good soaking.' This was the beginning of their (ultimately) vast and successful system of irrigation, since famous throughout the civilized world." Within a month (by August 26th) the pioneers had plowed and planted 84 acres with corn, potatoes, buckwheat, and turnips.

Salt Lake City was soon surveyed and laid out. Wood was cut in the nearby canyons, adobe bricks were made, and a stockade was erected. Wilford Woodruff says in his journal,

> We have accomplished more this year (1847) than can be found on record concerning an equal number of men in the same time since the days of Adam. We have travelled with heavily laden wagons more than 1000 miles over rough roads, mountains, and canyons, searching out a land, a resting place for the Saints. We have laid out a city two miles square, and built a fort of hewn timber seven miles from the mountains and of sun dried bricks or adobes, surrounding ten acres of ground, forty rods of which were covered with blockhouses, besides planting ten acres of corn and vegetables.

The small advance group of 147 persons was soon followed by the so-called "First Immigration" comprising 1553 persons under the command of Parley P. Pratt, which left Winter Quarters, July 4, 1847 and arrived in Salt Lake City September 19. This band of colonizers brought with it 580 wagons, 2313 oxen, 124 horses, 887 cows, 358 sheep, 35 hogs, and 16 chickens. Other settlers followed to augment the fast growing colony. For all it was a winter of hard work and careful planning. Flour was doled out by weight to each family, and sage and thistle roots were gathered for food. Lorenzo S. Young, who as a boy entered Great Salt Lake Valley in midsummer of 1847, records in his journal: "Rations grew scarce that first winter and one of my duties was to gather red roots, pig weed, and thistle. I lived in constant fear. Those hills held for me every terror known to human beings, but my cowardice did not prevent me from being sent out over them in search of food." An additional problem was that of shelter. Having had no previous experience in an

arid land, and supposing from the appearance of the ground in summer and fall that it was always dry in the valleys, they made the roofs of their houses flat. The result was that nearly every house leaked during the first winter. But fortunately it was a comparatively mild winter, so that they endured less hardship than would normally have been the case.

DESERET

The spring of 1848, their first in the valley, witnessed flourishing fields in this new land of Deseret.[4] Five thousand acres had been planted with wheat alone and promised a good harvest. At the beginning of the dry season near the end of May, however, myriads of Mormon crickets, *Anabrus simplex*, appeared and began to devour the crops. The people fought them, driving them into ditches and upon piles of burning reeds, striving in every way to stem this tide of destruction, but in vain. Then suddenly from the west, from the islands in Great Salt Lake, came thousands of sea gulls which devoured the crickets in a short time, thereby saving the settlers from famine. Although the pests partially destroyed the crops, the yield was sufficiently large to prove the practical value of irrigation.

Thus began man's adjustment to natural conditions in Utah, a region where no form of government had been established by either Mexico or the United States, where there were no means of acquiring title to land and where no system of water rights as yet existed. Under such circumstances it was natural that the Mormon Church should become the source of law in temporal as well as in spiritual matters.

IRRIGATION PROBLEMS

From every point of view the paramount problem was that of producing food by irrigation. Manufactured goods could be procured with difficulty and expense from the East, but food had to be raised within the area if this new land were to become the permanent abode of the settlers.

[4] The word "Deseret" means honey-bee. The State of Deseret was organized in 1849 for the protection of the Mormon settlements at the foot of the Wasatch.

The building of dams and canals was of necessity the work of coöperative activity, for so large an enterprise could not have been financed by any one individual. In addition, the canals had to be operated and maintained on a community scale. The prosperity as well as the very existence of the settlements depended upon coöperation. It was fundamental inasmuch as the basic industry was agriculture. Thus from the very first the canal was a community problem to be solved by the united skill and labor of the community.[5] Not all settlements are able to develop economic coöperation of sufficient strength to be effective, but the Mormons were actuated by religious sanction as well as by economic necessity. When a canal was built to supply the irrigation needs of several rural settlements, as was often the case, all those interested in the project labored on the canal from the source down to the point where the trench reached the lands of the nearest settlement or town. Then an estimate was made of the work done, and the water was divided accordingly among the various towns. At that point the first community would drop out of the work, and the construction would be carried forward by the remaining communities in the same manner until the completion of the canal, each succeeding town dropping out as its limits were reached.

In each irrigation project, the settlers were confronted by the problem of determining, in so far as topography permitted, the amount of land that would be rendered accessible to the water by the proposed system. Science has proved that the proper course was to construct a high-line canal, covering all the good land below the topmost level to which the water could be conducted. But the inexperienced pioneers, urged on by immediate needs, thought only of the present and made the best possible adjustments under the circumstances. Usually they constructed a canal at the level which would supply water only to the acreage demanded at the moment; and it was not until more settlers came in and more land was needed, that new canals were built at the higher levels. Thus contrary to the best engineering knowledge

[5] Thomas, George, *The Development of Institutions Under Irrigation* (New York, 1920), p. 18.

of today, several small canals at different levels are to be found irrigating an area which should really be supplied by one. By this duplication of canals in a single valley, much precious water is wasted, the soil is injured through seepage, and the area for settlement is appreciably reduced. An example of this is quoted from the Report of the Utah Conservation Commission in 1910:

> There is a district of 20,000 acres, where the first settlers took out a ditch for 200 acres. Later a ditch was taken out for 500, and so on until 10 or 15 ditches were constructed each operating under separate ownership. In each of these ditches there is a separate and distinct interest from the others. It must be patent to the interested observer that in this multiplicity of canals there will very naturally be a great waste of water from evaporation, leakage, etc., whereas if one or two canals were constructed to cover all the acreage the saving in cost of maintenance, in evaporation, and in leakage would justify in many instances the cost of construction, and still secure to the original proprietors full measure of protection of their priority of rights.

During the first few years following the original settlement in Utah only the better land and that readily accessible to irrigation streams was tilled. This land was just beneath the benches (deltas). It was loamy in texture and was fairly well-drained. As time passed and more settlers poured into the Oasis, more and more land had to be reclaimed for tillage. Naturally this expansion was at first directed down stream, because of the greater facility in handling the water. In a few years, however, practically all of this type of farm land within the immediate vicinity of Salt Lake City had been reclaimed. The higher lands then had to be used, and to get water for these it became necessary to go far upstream, often into the canyons where dams of considerable size were required. Blasting had to be resorted to frequently in order to open up a ditch along the side of a ledge. Flumes were constructed in some places. In the end the water was led out over the higher terraces, the ditches following the base of the foothills. Thus the agricultural area was expanded until the available water supply could serve no more land.

At first, irrigation of the bench lands had no deleterious effect

upon the original farms. Shortly, however, certain farmers began to notice that spots on their land were damp and becoming more so as time progressed. These areas became steadily larger until much of the lower lands was too wet for successful tillage. Excessive irrigation water applied at the higher levels percolated downward through the soil until it reached a layer of fine-grained soil, compact and nearly impervious. Flowing along this downward to a lower level, it came near the surface and formed a wet spot. Moreover, wherever the higher ditches crossed a porous soil formation, they lost a considerable amount of water by seepage, which in turn augmented the waste due to excessive application. Hence water-logging of lower lands became proportionately rapid and serious. Some of these lower lands were abandoned for tilled crops and turned into wet pasture land. The owners were usually compensated by tracts of higher land. The town of Draper in Salt Lake County was moved some distance because of the low-lying farm-lands becoming water-logged. A drainage district now covers the site of the original town. Such land when drained shows high productivity.[6]

GROWTH OF POPULATION AND COLONIZATION

The early growth of population in Utah was phenomenal. "There were 3000 persons before the end of 1848,"[7] 11,380 in 1850, and 40,273 in 1860. This marked increase was in part due to the arrival of those who had remained at Winter Quarters, until they received marching orders from Brigham Young. Soon practically all the good farming land within the environs of Salt Lake City had been parcelled out, and the Church leaders faced the problem of finding new lands suitable for colonization. Scouts were sent out to explore the nearby and distant valleys, and found many excellent sites, which were systematically settled according to plans formulated by the Mormon leaders. Utah

[6] Stewart, George, "A Farm-Management Study of the Great Salt Lake Valley," *Bulletin No. 184, Utah Agricultural Experiment Station* (Logan, Utah, 1923), pp. 10–11.

[7] Gallois, Lucien, "Quelques Notes Sur l'Utah," *Transcontinental Excursion of the American Geographical Society* (New York, 1915), p. 332.

stands among the American States as the one state to have been systematically colonized. Brigham Young, the great Mormon leader, directed the settlement in every valley. He personally picked the families and leaders for these infant communities. Only the strongest and best were chosen for this pioneer work, for only they could brave the hardships of the desert, subdue hostile Indians, exterminate the wild beasts, adapt themselves to the extremes of climate, and remain in those lonely valleys, hundreds of miles from the nearest white settlements, long enough to conduct water from the mountains to the land and change the desert into the oasis which it is today. The localities first chosen for settlement were obviously those which were favored by natural conditions and which offered to the new-comers the least hardships and danger in their reclamation. As these sections became settled, others more remote and less inviting as to physical conditions were colonized. G. K. Gilbert writes,

> . . . . rarely has the first selection made been final. Luxuriant vegetation has often tempted the settlers to select lands at too great an altitude, and many towns have been moved down stream. Sometimes selections have been made too far away from the sources of the streams, and to increase the supply of water, towns have been moved upstream. Sometimes lands of too great slope have been chosen, and here the waters have rapidly cut deep channels and destroyed the fields. Sometimes alkaline lands were selected and abandoned, and sometimes excessively sandy lands have caused a change to be made; but the question of the best sites for the construction of works for controlling and distributing water has usually determined the selection of lands within restricted limits. . . . . To a very slight extent indeed have artificial conditions controlled in Utah; the several problems have generally been solved by the consideration of physical facts.[5]

The spirit of colonization so marked in the leaders of the Mormon faith, coupled with a determination to make their new empire self-supporting, led them to push their borders from Cache

[5] Powell, J. W., *Report on the Lands of the Arid Region of the United States* (Washington, 1897), p. 89.

Valley on the north to the Virgin Valley on the south, a distance of more than 350 miles, within a period of 10 years after the first settlement at Salt Lake City. The keynote of the expansive policy of the Church is shown by an epistle issued at Salt Lake City by Brigham Young in March 1849:

> We are about to establish a colony of some thirty families in Utah Valley, about 50 miles south. We hope soon to explore the valleys 300 miles south and also the country as far as the Gulf of California with a view to settlement and to acquiring a seaport.

In the spring of 1849 a number of families, under the direction of the Church, entered Utah Lake Valley. Thirty families located on the Provo River about two miles west of the present site of Provo. Others located near the present sites of Lehi, American Fork, and Pleasant Grove, on streams which emerge from the mountains at these points, while still others established themselves on Spanish Fork River some distance west of the present town of Spanish Fork. Soon the tide of settlement turned toward the smaller valleys lying on tributary streams. The first settlement in Provo Valley was made in 1858, and the year following Juab and Goshen Valleys, which lie just south of Utah Lake Valley, were occupied. Expansion took place rapidly also north of Salt Lake City. Bountiful had already been occupied in 1847. In 1848 the population streamed northward to Centerville, Farmington, and Ogden. In 1850 the villages of Uinta and Slaterville sprang up near Ogden, while Willard was established in 1851 and Brigham City in 1853. All these towns are located at the foot of the Wasatch Mountains and are dependent upon the numerous streams which emerge from this range. In each case the size of the stream is a good index to the size of the town.

THE FARM VILLAGE

The problem of protection was a grave one at first, because the pioneers were greatly outnumbered by the Indians. The policy of Brigham Young, however, was to feed and not fight the Redman. Every "stake" became a fort, which embraced within

its walls the pioneer cabins. The fields were parcelled out in strips outside the fort and farming operations in time of trouble were frequently performed with sentinels posted nearby. This "close settlement" naturally fostered community villages as opposed to scattered farms. But it was not due to the need of protection alone that the pioneers lived in this manner. Brigham Young, coming as he did from New England (Vermont), understood the advantages of the old form of village or town government. His purpose required that the settlers should establish and maintain homes at a common center or town, surrounded by their farms, so that they might enjoy the privileges of worship, education, and social intercourse which go with community life. It was in the church meeting houses that the young people gathered and it was there that the men discussed what fences should be put up, what canals dug, what bridges constructed, and what roads made. Accordingly Utah and Salt Lake Valleys became a vast checkerboard of farms, dotted at frequent intervals by thrifty towns and rural villages.

SYSTEM OF LAND TENURE

In Utah small holdings prevailed. The maxim of the community provided or stipulated that a man should possess no more land that he could cultivate. Brigham Young, in framing his coöperative system of irrigation, taught his followers that if farming in this region were to succeed, there must be a small farm unit devoted to diversified production, intensively cultivated, and regularly fertilized. Brigham Young said in a sermon delivered on December 18, 1848.

> The immense labor of irrigating alone, to say nothing of the scarcity of water that exists in nearly every settlement during midsummer, at the very time the water is most needed, should be an incentive to the farmer to exert himself by a more thorough culture and a liberal application of every species of fertilization, to raise his sustenance from a smaller quantity of land.

He realized that value resided in water rather than in land. If he had settled in a humid region he would scarcely have imposed

such narrow limits upon the amount of land which individuals might acquire. But he had the intelligence to see that intensive tillage was the economic concomitant of irrigation. The first settlement, that of Salt Lake City, was adopted as the model for all others. An equitable division of land values was the ideal to be attained in the distribution of the land. Lots were divided into four classes according to their location. In the first tier, near the center of the city, the lots were valuable and hence measured one and a quarter acres. The second tier was composed of five acre lots, the third of ten acres, and the fourth of twenty acre lots. Every settler was to be a landed proprietor; there were to be no tenants. The amount of land assigned to each was to vary with its value as determined by location, and vary also with the calling of its owner. The smaller lots were assigned to professional and business men. Mechanics and artisans took the five acre lots, while the ten, twenty, and sixty acre tracts were given to farmers in proportion to the size of their families, and were to be held in individual ownership.[9] Thus the division of land values was remarkably even, for what one man lacked in the area of his portion he gained by its position.

The outlying lands were held in common, so that the Mormon towns were similar to the English communities. Nearby natural meadow land was treated as the old folk-land; the shares of pasture or hay meadows were apportioned according to the number of settlers desiring them. The range of the public domain became the property of the entire colony, and was used for grazing.

OPPOSITION TO MINING

Within two years after settlement, Brigham Young's dream of a great isolated empire was shattered by the discovery of gold in California. The great cross-country highway pierced Utah and the Mormon Oasis became a halfway post for the weary gold-seekers who here replenished their provisions and rested themselves and their footsore stock. Farm products advanced enormously in price at this sudden advent of a market. Flour

[9] Brough, Charles Hillman, *Irrigation in Utah* (Baltimore, 1898), p. 15.

sold after the harvest of 1850 at 25 cents per pound, sugar at 70 cents, and other food products proportionately. Many of the emigrants were destitute of provisions, but their wagons were loaded with valuable merchandise, which was exchanged for provisions and pack animals.

The discovery of gold in California rendered it difficult to restrain many Utah settlers from prospecting. The Church authorities feared that mining would break down their policy of orderly expansion within the Great Basin. In an address delivered at the Tabernacle, Young thus forcibly expresses himself: "I hope the gold mines will be no nearer than 800 miles, ... if you elders of Israel want to go to the gold mines, go and be damned. If you go I would not give a picayune to keep you from damnation." His advice that they remain on their farms was religiously followed.

Mining history in Utah dates back to the early 50's when lead ore was mined from deposits in Beaver County to provide the necessary ammunition for the pioneers, but the real exploration for metal deposits did not begin until the arrival of General E. P. Connor with a troop of California volunteers to establish Fort Douglas on the east bench at Salt Lake City. Many of these soldiers had prospected in California, and they felt the lure of the Wasatch and Oquirrh Mountains rising before them. Experienced miners were given frequent leaves of absence from the fort, and in every way were encouraged to prospect the surrounding hills. They made their first discovery in the summer of 1862 in the Oquirrh Mountains in Bingham Canyon, where today is one of the world's large copper camps. In the succeeding years the soldiers discovered many notable mines in the nearby mountains.

DRY FARMING

It was stated in an earlier paragraph that dry-farming on this continent was inaugurated in Utah. In 1863 Bear River City was founded by a company of Danes, who brought the water of the Malade River to irrigate their fields. After repeated experiments they became convinced that the water was so brackish

as to be injurious instead of beneficial, and they ceased to use it. In their desperation they plowed up some sagebrush land, planted grain, and awaited results. They obtained fair yields which indicated that dry-farming with its alternate years of crop and fallow could be established, and since that day dry-farming has been regularly practiced in that portion of the valley. A year or two later a pioneer plowed up some land on the now famous Sand Ridge between Ogden and Salt Lake City and demonstrated that wheat could be dry-farmed there on land generally held to be worthless.

SUMMARY

The foregoing pages have indicated that the story of Utah is the story of a people who converted a desert wasteland into an oasis by a definite plan of coöperative effort in handling their agricultural problems. Hence Utah is of especial interest because it is the home of modern dry-farming,[10] it is the place of the earliest significant development of irrigation in the West,[11] it was developed under a centralized power—the Mormon Church, and it is today one of the more important irrigated sections of the United States.

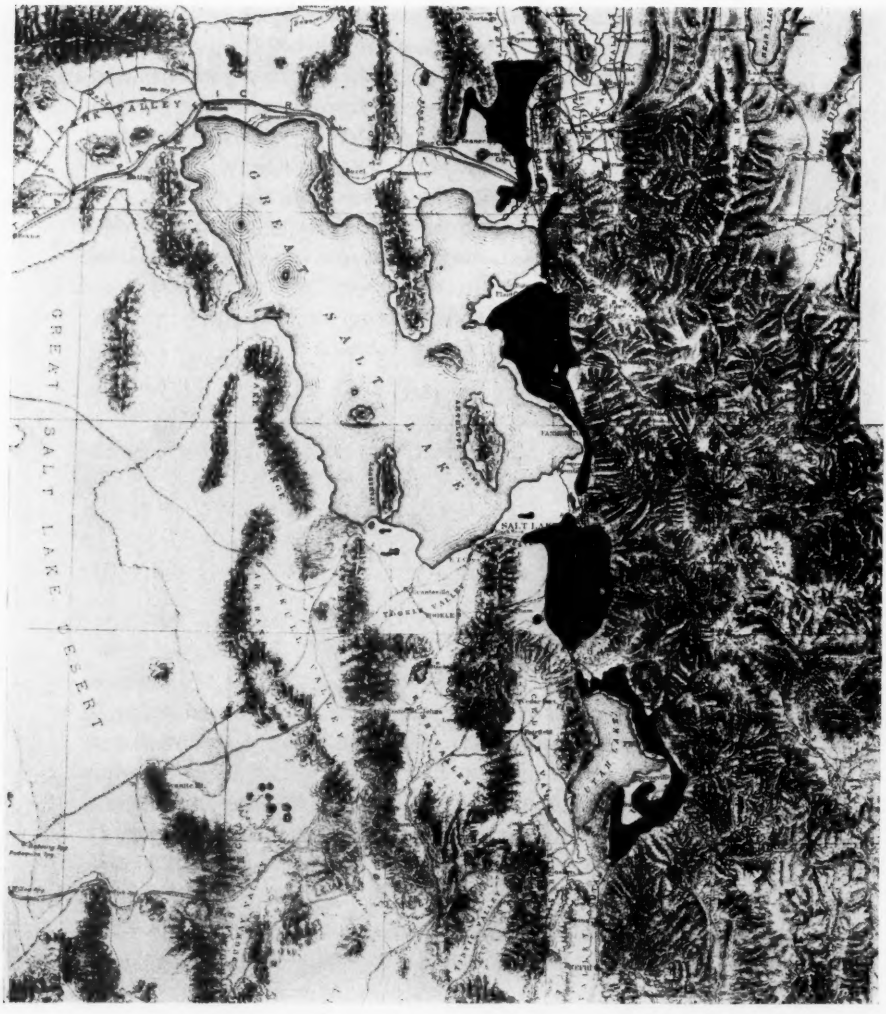
II. The Unity of the Area

At the western base of the Wasatch Mountains, in the midst of an arid wilderness, lies the Salt Lake Oasis, a strip of irrigated land about 130 miles long and from 2 to 18 miles wide, comprising Utah and Salt Lake Valleys. This Oasis consisting of Mormon farmlands with villages and cities interspersed among them is the garden spot of Utah and a distinct geographic unit (fig. 1).

BOUNDARIES

The lofty Wasatch Mountains, the easternmost of the basin ranges, bound the Oasis to the east. Upon them depends the economic existence of the region, because from their snow-clad slopes emerge the streams that supply the life-giving water to the

[10] Widtsoe, John A., *Dry Farming* (New York, 1911), p. 354.
[11] Thomas, George, *Op. cit.*, p. 13.



Scale, 27.5 miles per inch

FIG. 1. THE OASIS AT THE FOOT OF THE WASATCH MOUNTAINS
Approximate location and extent of irrigated land in the Salt Lake Oasis in 1923

thirsty plain below. These mountains and their high valleys differ from the Oasis in relief, elevation, natural vegetation, and crops, and hence they are considered not as a part of the Oasis, but as a part of the mountain region to the east.

Lakes, mountains, and desert delimit the region on the west. Utah and Great Salt Lakes comprise the water barriers, while the desert and the basin ranges (the West, Lake, Oquirrh, and Promontory Mountains and the Blue Spring Hills) form the land barrier. This entire mountain and desert area has slight agricultural value. A few of the slopes are dry-farmed with wheat, but most of the land, where utilized at all, serves only as winter range for sheep. Irrigation agriculture is restricted because of the small catchment basins of the watersheds. The few streams that flow from their canyons are lost by evaporation and seepage before they can be utilized for irrigation.

Low hills define the Oasis on the south. They extend across Utah Lake Valley near Santaquin, about 18 miles south-southwest of Provo, and separate it from the neighboring Juab Valley to the south. A line of sharp economic demarcation emphasizes this physiographic boundary. North of these hills is the Oasis, a region intensively tilled; south of them is a series of north-south valleys extensively tilled. The former is characterized by small holdings, high-priced land, dense population, adequate water for irrigation and domestic use, satisfactory markets, numerous farm villages, a few cities, and excellent transportation facilities: the latter, on the other hand is characterized by an absence of practically all these economic features. A marked contrast of farm business in the two regions, consequent upon topographic, climatic, soil, and economic differences, is indicated by data gathered from numerous farm records during the period 1914–1916 inclusive. Whereas the sources of income in the Oasis were derived from sugar beets, fruit, vegetables, dairy products, alfalfa, wheat, and livestock, those in the area to the south were obtained almost wholly from alfalfa (both hay and seed), dryland wheat, and sheep and cattle sales. Alfalfa, which occupied more than 75 per cent of the tilled land in the latter region, was used as winter feed and marketed through fattened stock. The

greater the distance from market, the greater was the proportion of income derived from livestock, because the animals could be driven to market.

The northern boundary, while not so topographically evident, is nevertheless as geographically definite. South of this boundary water is "lifted" from the Bear River, which breaks into Salt Lake Valley at the "Gates" just opposite Fielding and is used for irrigation. North of this line, however, the land, because of its upslope, cannot be reached by gravity canals and thus necessarily precludes irrigation agriculture. Consequently different systems of farming prevail on the two sides of the boundary. Dry-farming and stock rearing are found northward as far as Malade, Idaho, about 27 miles distant, while irrigation farming in all its completeness is practiced in the Oasis to the south.

THE UNITY OF THE AREA

The Salt Lake Oasis is a distinct geographic unit, as is indicated not only by its physical character but by its economic and social evolution. Here along swift streams emerging from the Wasatch or on the banks of sluggish valley rivers "in cozy towns and villages, girdled by green fields and smothered in orchards and shade trees," live three-fifths of the people of Utah. Here, also, is carried on most of the farming and manufacturing of the state. To natives and visitors alike this narrow ribbon at the foot of the Wasatch is "Utah."

VALLEYS AND LAKES

Utah and Great Salt Lake Valleys are essentially "structural troughs," continuous in a sense with those extending north and south almost the entire length of the state, but separated one from the other by low debris-covered divides. The physiographic features of these valleys are products of ancient Lake Bonneville.[12] They are underlain by almost flat unconsolidated lacustrine sediments, and their borders are marked by a unique series

[12] Gilbert, G. K., "Lake Bonneville," *Monographs of the U. S. Geological Survey*, Vol. I (Washington, 1890).

of terraces, which indicate the shore lines of the ancient lake (fig. 2). "Through a vertical interval of 1000 feet the story of the rise and fall of this body of water is recorded by the superposition of shore line upon lake sediment and of lake sediment upon shore line."[13]

The remnants of old Lake Bonneville,—Utah and Great Salt Lakes, lie respectively 4491 and 4210 feet above sea level. From these elevations the valleys rise to the outer borders of the basins, which may be taken for the sake of convenience as the

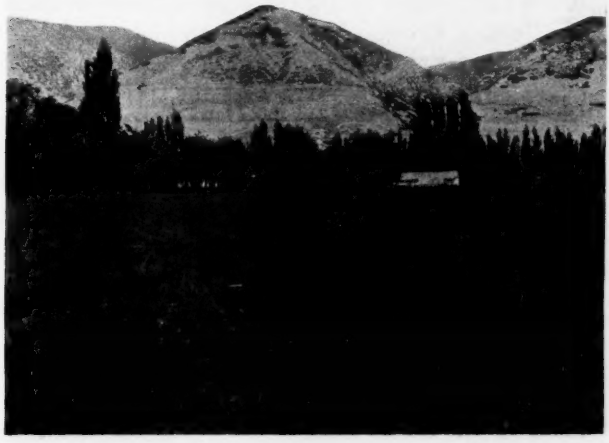


FIG. 2. TERRACES OF OLD LAKE BONNEVILLE NEAR CENTERVILLE
(C. C. COLBY)

highest level occupied by Lake Bonneville, at about the 5200 foot contour. Utah Lake, a shallow body of fresh water 22 miles long and 10 miles wide, covers an area of about 93,000 acres. Its average depth slightly exceeds 8 feet. Its shore line is subject to considerable variation, owing to the changing relations of evaporation, precipitation, inflow, and use of the water for irrigation; the margins accordingly are swampy. Two large,

[13] Richardson, G. B., "Underground Water in the Valleys of the Jordan River and Utah Lake," *Water Supply and Irrigation Paper 157* (Washington, 1906), p. 12.

shallow bays extend southward and eastward from the main body of the lake, one north of Goshen and the other south of Provo. It has been estimated that the annual evaporation from Provo Bay alone exceeds 28,000 acre feet of water. Plans are now under consideration for diking off this bay, draining the water, and reclaiming its 7800 acres, and thus securing new land that could be irrigated by the waters now flowing into it. The sediments on the bottom of Provo Bay are remarkably rich and very deep; once the water is drained off and the lands brought under cultivation, the district will make one of the most fertile spots in all Utah. Utah Lake serves as a great natural reservoir for irrigation. The Jordan River, which drains the lake, is tapped by numerous ditches between the "Narrows" and Great Salt Lake.

Great Salt Lake, America's sea of brine, occupies the main depression within Great Salt Lake Valley. It is the largest inland body of water west of the Mississippi River, and like Utah Lake, is variable as to its area. This is due to the fact that a small change in the height of the water surface makes a considerable change in the area of the lake. On a map made in 1850 the area of Great Salt Lake was given as 1750 square miles. In 1869, 19 years later, another map was made and the area was found to be 2170 square miles. Thus during the time between the two surveys the lake had risen 10 feet, thereby increasing the area 24 per cent.[14] Professor James E. Talmadge says: "The valley floor, on the lowest part of which the lake rests, is conspicuously flat, so that a slight fall of the water level gives rise to what appears to be a disproportionately great recession, and a rise of a few feet would result in flooding the valley nearly to the Wasatch benchlands, and in resubmergence of a considerable part of the Great American Desert."[15]

Many have thought that the increase in the area of the lake was only apparent, but this is not the case. Major John Powell wrote in 1877,

[14] Campbell, M. R., "Guidebook of the Western United States," *Bulletin 707, United States Geological Survey* (Washington, 1922), p. 246.

[15] Talmadge, James E., "The Great Salt Lake," *Scottish Geographical Magazine*, Vol. XVII (Edinburgh, 1901), pp. 619–621.

The farmers of the eastern and southern margins have lost pastures and meadows by submergence. At the north, Bear River Bay has advanced several miles upon the land. At the west, a boat has recently sailed a number of miles across tracts that were traversed by Captain Stansbury's land parties. That officer has described and mapped Strong's Knob and Stansbury's Island as peninsulas, but they have since become islands. Antelope Island is no longer accessible by ford, and Egg Island, the nesting place of the gulls and pelicans, has become a reef. Springs that supplied Captain Stansbury with fresh water near Promontory Point are now submerged and inaccessible; and other springs have been covered on the shores of Antelope, Stansbury, and Fremont Islands.[16]

Major Powell accounted for this increase in area on the theory of human agency. G. K. Gilbert rallying to his support wrote,

On the whole, it appears that the white man causes a greater percentage of the precipitation in snow to be melted and a less percentage to be evaporated directly. This follows from the destruction of trees and grass. By reducing the amount of vegetation he gives a freer flow to the water from rain and melting snow and carries a greater percentage of it to streams, while a smaller percentage reaches the air by evaporation from the soil. By the treading of cattle he diminishes the leakage of the smaller water channels, and conserves the streams gathered there. By the same means and by digging of drains he dries the marshes and thereby enlarges the streams. In all these ways he increases the outflow of the land and the inflow of the lake. He diminishes the inflow in a notable degree only by irrigation.[17]

Considering the theory of climatic change and that of human agency as the two most reasonable hypotheses, Gilbert says further,

On the whole, it may be most wise to hold the question an open one whether the water supply of the lake has been increased by a climatic change or by human agency. So far as we know, neither theory is inconsistent with the facts, and it is possible that the truth includes both. The former appeals to a cause that may perhaps be

[16] Powell, John, *Report on the Arid Region of the United States* (Washington, 1879), p. 67.

[17] *Ibid.*, p. 75.

adequate, but is not independently known to exist. The latter appeals to causes known to exist, but quantitatively undetermined.

It is gratifying to turn to the economic bearings of the question, for the theories best sustained by facts are those most flattering to the agricultural future of the Arid Region. If the filling of the streams and the rising of the lake were due to transient extreme of climate, that extreme would be followed by the return to a mean condition, or perhaps by an oscillation in the opposite direction, and a large share of the fields now productive would be stricken by drought and returned to the desert.

If the increase of water supply is due to a progressive change of climate forming part of a long cycle it is practically permanent, and future changes are more likely to be in the same advantageous direction than in the opposite. The lands now reclaimed are assured for years to come, and there is every encouragement for the work of utilizing the existing streams to the utmost.

And finally, if the increase of water supply is due to the changes wrought by the industries of the white man, the prospect is even better. Not only is every gain of the present assured for the future but future gain may be predicted. Not alone are the agricultural facilities of this district improving, but the facilities in the whole Rocky Mountain Region are improving and will improve. Not only does the settler incidentally and unconsciously enhance his natural privilege, but it is possible, by the aid of a careful study of the subject, to devise such systematic methods as shall render his work still more effectual.[18]

This increase in the water supply pertains also to the tributary valleys. Between 1850 and 1860 Mormons occupied the site of Kaysville for the first time. For some years after settlement, a dozen families composed the entire population, and they discouraged additions to their numbers, because of the scant water supply. The diminutive creek, on the banks of which the tiny scattered village had been established, scarcely supplied enough water for the irrigation of the holdings tilled by the settlers. Kaysville is now (1920) a thriving rural village of 809 people. Similar conditions prevailed in the history of adjacent towns. In 1856 10 families composed the population of Farmington and 14 that of Bountiful. These places are now prosperous towns,

[18] *Ibid.*, pp. 76–77.

the first having a population of 1170, and the second supporting 2063 persons. The dominant pursuit of the people is still agriculture, and water is needed for every farm. Yet there is now an adequate supply, and additions to the farming population are encouraged by each town. At an early date the Oasis farmers became interested in the cause or causes why the extension of their farm operations was possible with no increase of the available amount of water. A typical explanation follows:

> Taking together the facts as to seepage of water from rivers or ditches, and those relating to the rising of water by means of what is called capillary attraction, one is furnished with the key to the gradual diminution of the water necessary for irrigation of the same land, which has been noted in almost every part of the West. . . . . The ranch owner, who doubted if his spring or brook would suffice for 20 acres, extends the area of his cultivation bit by bit until it reaches 80 or 100 acres, and he still has some to spare. Bishop Musser of Salt Lake, who has made a special study of irrigation in Utah and abroad, states that when the city was first founded there was only water enough from a particular source for 800 or 900 acres, while now the same amount supplies more than 5000 acres.[19]

RIVERS AND CREEKS

Most of Utah's agricultural land is found between Fielding and Santaquin in the fertile strip at the foot of the Wasatch, where numerous streams emerge from the mountains and flow toward Utah and Great Salt Lakes. Along the entire extent of the Oasis the wall of the Wasatch is seamed by a series of streams whose waters are diverted for purposes of irrigation in the valley lowlands. The streams which serve in this capacity are: Bear River, Box Elder and Willard Creeks, Ogden and Weber Rivers, Kay's, Bear's, Farmington, Pine, Ward, Holbrook, Mill, City, Red Butte, Emigration, Parleys, Mill, Big Cottonwood, Little Cottonwood, Willow, Dry, American Fork, Butte, and Grove Creeks, Provo River, Hobble Creek, Spanish Fork River, and Payson and Santaquin Creeks. The Jordan River, which rises

[19] Hinton, Richard J., *Irrigation in the United States* (Washington, 1890), p. 310.

in Utah Lake, is the only stream that does not flow from the Wasatch. The chief Oasis rivers are the Bear, the Weber, the Provo, and the Jordan, and "upon their water will ultimately depend the major part of the agriculture of Utah," said G. K. Gilbert in 1877. The realization of this forecast is apparent to anyone traveling through irrigated Utah.

Bear River has its sources well within the Uinta Mountains. It flows north in Utah, then in Wyoming, and on into Idaho as far as Soda Springs; thence it bends around like a fish hook and returns in a southwest direction, re-entering Utah by way of Cache Valley. The river leaves this valley through a short transverse canyon and enters Great Salt Lake by way of what is locally called Bear River Valley, but which is really a part of that of the Great Salt Lake. The limestone walls of the transverse canyon (the "Gates") provide an excellent foundation for the headworks of a system of canals which supplies the plain south of Fielding. Practically the entire alluvial plain of the Bear is served as well as a goodly portion of the Malade, the only large tributary received by the Bear in the Oasis. The brackish water of the Malade, however, is useless for irrigation.

Weber River has its source on the northwestern slope of the Uinta Mountains about 25 miles due east of the southern extremity of Great Salt Lake. This stream, which with its tributaries drains an area of about 1600 square miles, takes a short cut through the Wasatch Mountains and enters Great Salt Lake just northwest of Hooper near Ogden. Its extensive delta plain forms most of the irrigable land of Weber County.

Provo River, like the Bear and Weber Rivers, rises in the summits of the Uintas in a number of small lakes, approximately 70 miles from Utah Lake into which it debouches. It receives tributaries along its entire course, and drains altogether an area of 800 to 1000 square miles.

The River Jordan heads at the north of Utah Lake and discharges into Great Salt Lake. At the Jordan Narrows, the stream has cut through low mountains, remnants of an old lava flow. From the Narrows to its mouth, a distance of about 35 miles, the river falls 250 feet, chiefly during the first few miles.

This natural feature has facilitated the construction of canals and the irrigation of the lower bench lands.

The slope of the bench lands from the mountains toward the river is so great, however, that the canals heading in the Narrows parallel the river at a short distance for about 15 miles. At that point the slopes on the west side of the river flatten out and the canals draw rapidly away toward the northwest. The canals on the east side also follow the general course of the river for about the same distance, when they come to the valleys watered by the streams from the mountains, where irrigation extends clear up to the base of the hills. The part of this area depending on the Jordan for water is all the land on the west side of the river which can be reached by canals, and all the land on the east side of the river below the line of the East Jordan Canal and south of the canals from Little Cottonwood Creek.[20]

MOUNTAINS

The mountains on either side of the Oasis form the dominant topographic features of the region. The Wasatch Range to the east is a vast block of red-sandstone and quartzite that has been elevated at its western margin. This elevated portion has been greatly eroded, so that its surface is a labyrinth of rugged mountains separated from one another by valleys, canyons, and gorges. The western face of the range, which at one time was nearly straight and possibly was a single cliff, is still very precipitous and forms the great fault scarp which is so impressive along the whole extent of the Oasis (fig. 3). While these mountains do not equal in height either the Sierra Nevada to the west or the Rockies to the east, they are nevertheless one of the dominant American ranges and their snow-clad peaks vary in elevation from 10,000 to more than 12,000 feet above the sea. The impressiveness of the Wasatch, however, is due to its location on the edge of a flat plain rather than to its height, though both factors combine to make it a conspicuous mountain system.

On the opposite side of the valleys the low barren basin ranges stand out in contrast to the stately Wasatch. The most promi-

[20] Teele, R. P., "Irrigation from the Jordan River," *Report of Irrigation Investigations in Utah* (Washington, 1903), p. 40.

nent of these is the Oquirrh Range, which is about 30 miles long and from five to ten miles wide. Its northern end is 18 miles west of Salt Lake City and nearly two miles south of Great Salt Lake. The highest summits of this range rise 5,000 feet above the plain. The Oquirrh Range abounds in rich ores of silver, lead, and copper, which are now extensively mined.

FIG. 3. FAULT SCARP OF THE WASATCH EAST OF SALT LAKE CITY (W. W. ATWOOD)

SOILS

The soils of the Oasis are exceptionally deep and productive, having been laid down in ancient Lake Bonneville. During the lake period the washings from the upper valleys and mountains contributed largely to the filling of the lake, and in numerous places amassed detritus hundreds of feet thick. The bed of the old lake has thus afforded the richest valleys and the best farming areas in the state, as well as great areas of worthless desert and alkaline soils to the west where irrigation is impossible. Benches or deltas, consisting largely of gravel, lie near the canyon mouths where the still water caused immediate deposition. These deltas are well drained and therefore afford excellent land for

orchards, because the soil is enabled to warm up early in the spring. They are found only on the east side of the valleys because no large streams entered the old lake from the west. The sides of the valleys were mantled with sandy and loamy material by the receding water while clay was deposited on the valley bottoms. The well drained middle belt on the valley slopes affords by far the best farming land, because it is free from alkali and contains only small amounts of gravel. In contrast the valley bottoms, where seepage water collects in heavy clay soils, are likely to be alkaline or to become so, especially if the higher lands are over-irrigated, as they often are in Utah.

All the Oasis soils are well provided with phosphorus and potash, elements deficient in many soils of the United States, but they are lacking in humus and nitrogen. The rock materials furnishing the basis of these soils are largely of limestone origin, having been weathered from the adjacent mountains.

CLIMATE

The prevailing winds reach the Great Basin by descent across the Sierra Nevada or the Rockies, and therefore make the climate of the Oasis arid. The isohyets for central Utah and the monthly precipitation for a typical Oasis station are shown in figures 4[21] and 5. They reveal for the Oasis an annual mean of only 15 to 20 inches. The relative humidity is low, averaging about 52 per cent, as against 70 to 75 per cent for the region from Kansas eastward, and 75 to 80 per cent for the coastal sections of the country. The sensible temperature, also, is low. A summer temperature at Salt Lake City of 105° F. feels no warmer than one in the humid East of 90° F. The rate and amount of evapo-

[21] All available data for the Oasis and its immediate hinterland have been entered upon this map. No data, however, are available for the highest levels either in the Wasatch or the Uintas, and since there is "no convenient artifice for representing 'no data,'" it has seemed desirable to show the "probable conditions." These have been based upon natural vegetation and altitude and are represented by dotted lines. The writer is indebted to Mr. J. Cecil Alter and Drs. O. E. Baker and C. F. Brooks for assistance in making this map.

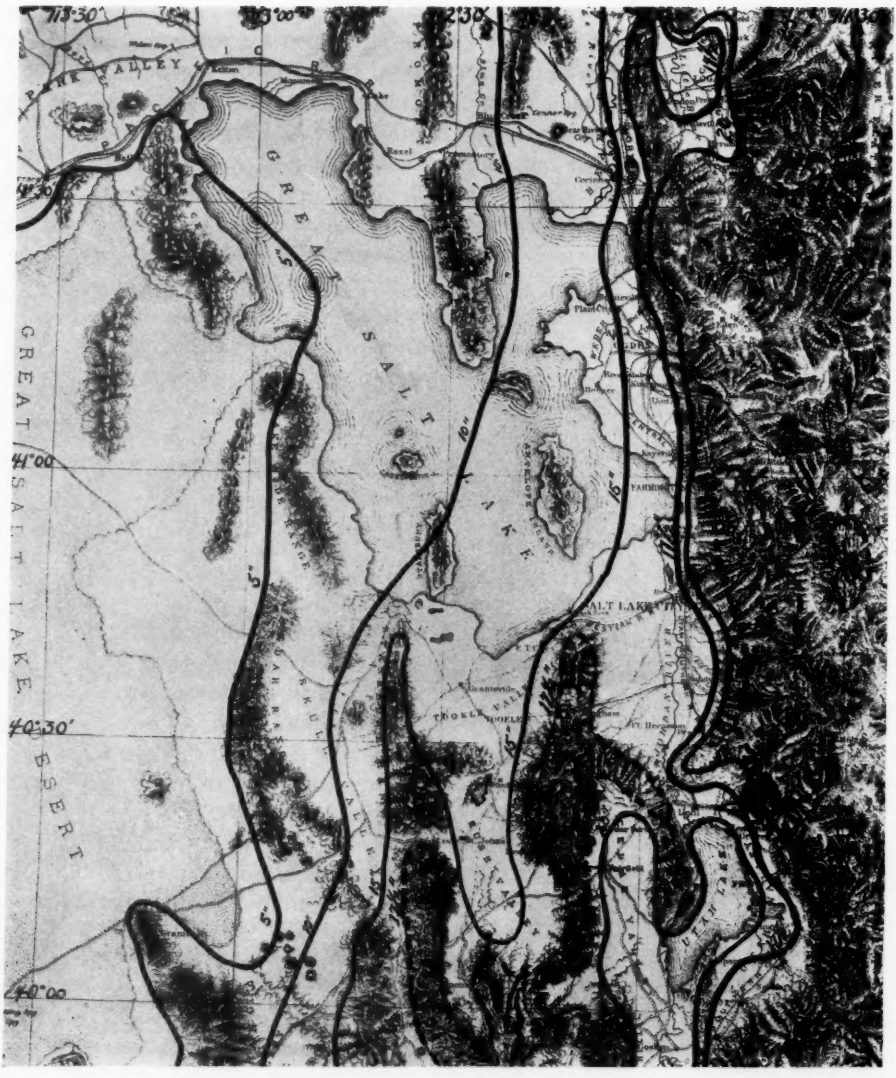


FIG. 4. ANNUAL ISOHYETAL MAP

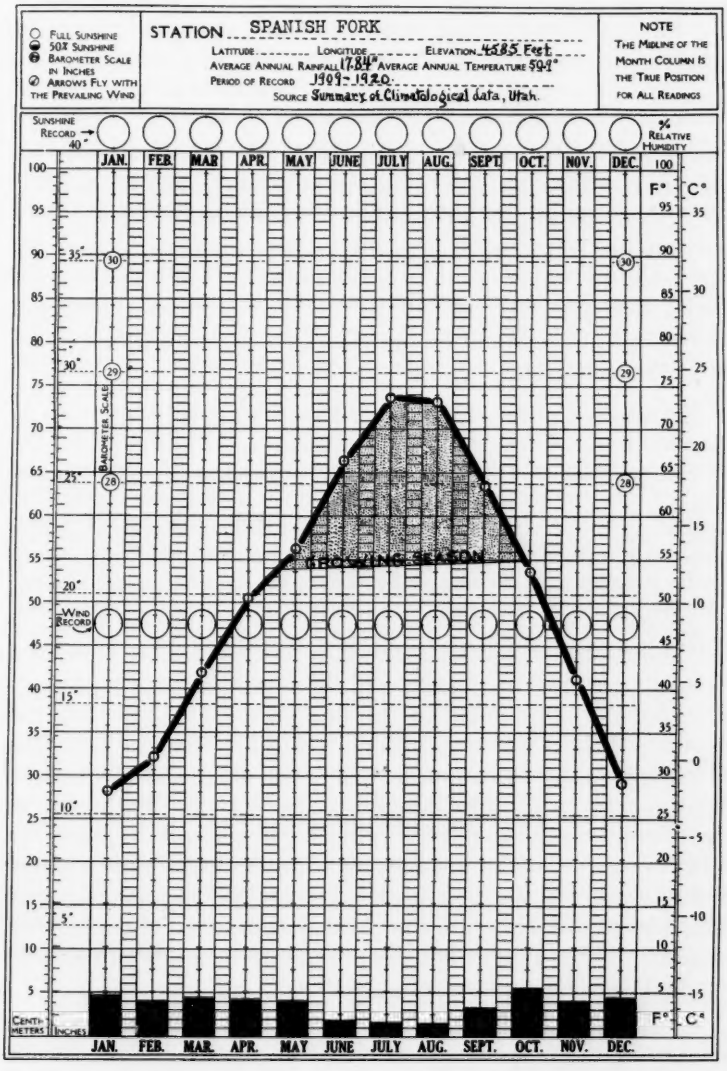


FIG. 5. PRECIPITATION, TEMPERATURE, AND GROWING SEASON AT SPANISH FORK

ration are great because of the low humidity, the fair winds (7.8 miles per hour at Salt Lake City), and the large amount of sunshine (62.4 per cent of the possible at Salt Lake City).

Precipitation

The rainfall in Utah has been accurately measured at many stations, most of which are in the more densely populated sections, particularly Great Salt Lake and Utah Lake Valleys. It has been measured at a few moderately high stations, but at none of the highest levels, either in the Wasatch or the Uintas. The amount varies from 4 to 28 inches at those stations between 2800 and 10,000 feet, though more than 30 inches probably falls on the mountain summits.

> The great variations in the amounts received at different points in the state are due almost entirely to topography. As a rule the stations on the western slopes receive more than do those on the eastern, and stations near the mountains more than those on the same slope, but farther away from the base of the mountains. Stations at higher levels receive more than those at lower levels as a rule; but stations at the same level on different sides of a mountain will receive different amounts, the side toward the rain-bearing winds receiving the more.[22]

The increase of precipitation with altitude begins at a considerable distance to windward of the mountains and progresses at a fairly constant rate on the gradual ascent, until near the summits of the mountains, where it begins to decrease. The area of diminished precipitation, however, is limited and therefore of little consequence. The rainfall on the Wasatch Mountains at elevations ranging from 7500 to 8700 feet is about 10 times the amount received on the saline deserts 75 miles to the west. While the altitude relation is irregular due to local topography, the increase is strikingly uniform over the gradual uninterrupted slopes.[23] Table 1 indicates the average seasonal distribution of precipitation for representative stations.

[22] Thiessen, Alfred H., "Precipitation," *Third Report of the State Bureau of Immigration, Labor, and Statistics, 1915–1916* (Salt Lake City, 1917), pp. 129–130.

[23] Alter, J. Cecil, "Normal Precipitation in Utah," *Monthly Weather Review*, September, 1919 (Washington), pp. 633–634.

The heaviest precipitation falls during the winter and spring periods. This condition favors the production of dry-land wheat on the bench-lands because most of the vegetative growth of cereals takes place prior to June. The summers are normally very dry; the little rain which falls comes in light thundershowers and has therefore little value. But this condition favors the raising of wheat, which requires dry weather during its final period of maturity and during harvest season. For the successful cultivation of most crops, however, the farmers find it necessary to resort to irrigation.

Much of Utah's precipitation comes in the form of snow. Approximately 54 inches of snow are received in the Oasis each year, most of which falls during the four months December to

TABLE 1

Seasonal distribution of precipitation in inches

STATION	ELEVATION	TOTAL	WINTER	SPRING	SUMMER	FALL	PERIOD
	feet						*years*
Corinne	4,240	12.51	4.00	3.89	1.71	2.91	50
Brigham	4,305	17.31	4.86	5.64	2.26	4.55	15
Ogden	4,310	15.15	4.82	5.07	1.72	3.54	50
Farmington	4,267	20.67	6.54	7.01	2.39	4.73	28
Salt Lake	4,408	16.23	4.17	6.08	2.10	3.88	47
Provo	4,532	15.07	4.67	4.74	1.97	3.69	32

March inclusive. The maximum amount, about 14.6 inches, is received in January. Snow is usually recorded in October and in May though occasionally there are traces in September and June. Mountain snows are always heavier than those in the valleys. From rough measurements made by the watchman of the Brighton Hotel in Big Cottonwood Canyon in the Wasatch Mountains, it appeared that 47 feet of snow fell between October 1 and April 23, 1912.[24] On the latter date a snow survey party found snow to a depth of 7½ feet at this hotel.[25]

[24] The elevations of Main Canyon and Brighton Basin vary from 8700 to 9540 feet.

[25] *Monthly Weather Review*, March, 1912, p. 435; April, 1912, p. 610; May, 1913, p. 771.

These winter snows that fall and accumulate in the mountains melt slowly during the spring and summer seasons. If the fall is heavy, the streams are fed by the melting snows during the entire growing season and furnish the dry lower valleys with an adequate supply of irrigation water. But if the fall is light, as is sometimes the case, a scarcity of water is felt during the critical season. The probable amount of water for irrigation is of primary importance, for upon it largely depends what crops shall be grown. The Oasis farmers anxiously watch the amount of snowfall in the mountains, and gauge their crops by the quantity and time of the snowfall. If it begins early, they feel confident of adequate water for late crops, but if it begins late (in the spring months) they fear a short water supply for summer and fall, and plant accordingly.

All the streams in this mountainous country thus are subject to marked fluctuations. Streams with headwaters in the high mountains reach their highest stage in June and their lowest in September or October. Streams rising in less high mountains attain their maxima in April or May, and reach their low stages in August or September.

In the lower valleys the small grains are irrigated from June first until the latter part of July. The irrigation of potatoes and corn begins about July first and continues until about the middle of August.[26] By the middle of July all the land calls for water, and if the supply is sufficient at that time, the "critical season," it is sure to meet the demands in the other seasons of the year. In the higher agricultural valleys, corn is not grown, but the irrigation of hay and small grains is carried on from about the middle of June till about the latter part of August.

Winds

In theory if not in fact the Oasis lies in the path of the Prevailing Westerlies, and these winds should be adiabatically cooled as they ascend the precipitous slopes of the Wasatch and deposit

[26] L. G. Connor, Bureau of Agricultural Economics, states that in Utah Valley the farmers irrigate the small grains from May 1 to July 1, and potatoes from May 1 to September 1.

moisture there. Contrary to expectations, however, the region has a prevailing southeast wind. But this is probably air drainage and does not represent the general flow of air over the region. The Annual Report (of the Chief) of the Weather Bureau for 1896–1897, for instance, gives for the five year period 1891–1895 at Salt Lake City, which may be considered as typical of the Oasis, the following:

2241 hours of southeast wind
1883 hours of northwest wind
936 hours of south wind
888 hours of east wind
785 hours of west wind
682 hours of southwest wind
634 hours of north wind
561 hours of northeast wind
3690 hours of N.E., E., and S.E. winds, against—
3350 hours of N.W., W., and S. W. winds

However, Salt Lake City's rainiest months, March, April, and May, had 785 hours of northwest wind to 460 of southeast. The wind at Salt Lake City seems to be in the northwest during most of the heavier rainfalls. The northwest may well be the rainwind, since the longest axis of Great Salt Lake stretches in a northwest direction from the city. The wind probably has a very low humidity when it reaches the lake, and consequently takes up considerable vapor from its surface. It promptly comes in contact with the Wasatch Range, however, and drops much of its moisture.

Temperature

The Oasis has the invigorating temperatures so characteristic of the plateau section of Western United States. The spring and fall months with average temperatures of 50° and 51°F. respectively (table 2) are very pleasant. Although comparatively high temperatures occur during the afternoons of the summer months, the difference between the actual and the sensible temperature is so great that the days are not oppressive. The nights are always cool. The winters are generally cold and dry, the average temperature for December to February inclusive being 30°F.

The annual mean temperature for the Oasis is 51°F., the highest recorded is 110°F., and the lowest −23°F., giving an extreme range of 133°F.

The great number of warm, uniform, clear summer days hastens the growth and maturity of crops. The average date of the first killing frost in the fall is September 28th at Corinne on

TABLE 2

Seasonal distribution of temperatures

STATION	WINTER	SPRING	SUMMER	FALL
	°F.	°F.	°F.	°F.
Corinne	27.4	49.7	73.9	50.8
Ogden	30.9	51.4	74.9	51.8
Farmington	30.9	48.7	69.7	49.8
Salt Lake	31.6	49.7	72.4	52.6
Provo	28.8	48.8	68.9	49.6

TABLE 3

*Frostless season**

STATION	ELEVATION	AVERAGE DATE OF LAST KILLING SPRING FROST	AVERAGE DATE OF FIRST KILLING FALL FROST	FROSTLESS SEASON
	feet			*days*
Corinne	4,240	May 19	September 28	132
Ogden	4,310	April 29	October 9	163
Farmington	4,267	May 10	September 30	143
Salt Lake City†	4,408	April 20	October 19	182
Midvale	4,365	May 22	September 14	115
Lehi	4,550	May 16	September 18	125
Provo	4,532	May 24	September 21	120
Spanish Fork	4,585	May 2	October 6	157

* West, F. L., and Edlefsen, N. F., "The Climate of Utah," *Bulletin No. 166, Utah Agricultural College Experiment Station,* (Logan, 1919), pp. 64–66.

† The extra length of the frostless season here is probably due to artificial temperatures caused by city heat and smoke.

the plain, and October 9th at Ogden on the bench. The average date of the last killing frost in the spring is May 19th at Corinne and April 29th at Ogden. The average frostless season for the Salt Lake Oasis is 142 days (table 3).

While the frostless season in the Oasis is comparatively long,

scarcely a year passes without some damage being done to farm crops by frost. For example, in the spring of 1916 the tops of young sugar beets were frozen, about a quarter of the grain of northern Utah was nipped, the yield of the first crop of alfalfa was reduced one-half, and 90 per cent of the fruit of the state was destroyed. During the months when fruit buds are in bloom, the report of the United State Weather Bureau shows that on an average covering 10 years for the Oasis counties, freezing temperatures of 30° or below are experienced 6 nights a year. The county agricultural agents report that 3 years out of every 10 the fruit crop is considerably below normal.[27]

Since in late winter spasmodic warm spells, closely followed by killing frosts, visit most fruit lands, the best locations for orchards, especially the peach orchards, are the bench lands, where the danger from such occurrences is considerably diminished. This is because the valleys are inclosed by lofty mountains, which delay the morning sunshine and advance the shadows in the evening, thus really shortening the day. This retards the opening of the fruit buds until spring has actually arrived. The shadow protection for orchards in Salt Lake Valley averages from 30 minutes to 2 hours in the morning and from one-half to one-fourth as long in the evening, depending upon the location of the orchard in question. The morning protection is afforded by the Wasatch Mountains, while that of the evening is produced by the less high Oquirrhs.[28]

The benchland orchards get additional protection due to air drainage, "the helpful influence of a steady stream or current of air which usually flows down a mountain slope all night, ceasing only when the morning sun appears and changes the direction of flow gently back up the slope."[29] These orchards, therefore get on the average a start of about 2 weeks over the area at the bottom of the valleys. This difference is reflected in the crops

[27] West, Frank L., and Edlefsen, N. E., "Orchard Heating," *Bulletin No. 161, Utah Agricultural Experiment Station* (Logan, 1917), p. 3.

[28] Alter, J. Cecil, "Crop Safety on Mountain Slopes," *Yearbook of the Department of Agriculture* (Washington, 1913), p. 314.

[29] *Ibid.*, p. 314.

of the two sections. The lowlands are planted almost wholly with hardier crops, such as vegetables, sugar beets, alfalfa, and grain, while the higher irrigated slopes are dotted with orchards, interspersed with berry vines.

Evaporation

The rate of evaporation has not been observed at many places; but those few which yield available records indicate the average

TABLE 4

Salt Lake Oasis evaporation records

STATION	PERIOD	ELEVATION	TYPE OF PAN	AMOUNT
		feet		*inches*
Fort Douglas.....	April to September, 1890–1892			30.7
Provo.....	March to December, 1910	4,532	Heavy galvanized iron tank 3 feet square and 17 inches deep sunk 15 inches in the ground	25.62
West Portal.....	May to October, 1911	7,500	Same as at Provo	15.29
Lehi.....	March to December, 1903	4,505	Galvanized iron 3 feet in diameter and 3 feet deep, sunk 3 feet in the ground	48.63
Nephi*.....	April to October, 1909–1917	5,119	Cylindrical pan 6 feet in diameter and 2 feet deep, sunk into the ground 20 inches, with water level maintained at the height of the surface of the ground	48.9

*About 19 miles south of Santaquin.

for the Oasis to be about 50 inches. Table 4 shows the evaporation for typical stations, though such conditions as the size of the pan and elevation make it impossible for the stations to be comparable one with another. However, it is evident that the evaporation at Nephi is about 19 and 14 inches greater from April to September than in the Ohio and lower Missouri Valleys at Cincinnati and Columbia respectively.

NATURAL VEGETATION

The natural vegetation of the benches and the lacustrine plain reflects the arid climatic conditions of the region. The well-drained bench lands within the Oasis are occupied chiefly by the sagebrush association; the dry saline land near the center of Salt Lake Valley is covered with a vegetation of white sage or of shadscale; the land in the lower part of the valley where the surface is dry but where the subsoil is moist, bears a mixed vegetation of greasewood and shadscale; the lowest places near the lake shore, which have a strongly saline surface and a wet subsoil, bear the salt flat type of herbage; and the moist moderately saline areas that lie between the two preceding are occupied by grass flats. Thus the natural vegetation of the region consists of several easily recognized plant communities, the distribution of which is determined largely by moisture relations and the salt content of the soil. These types of vegetation are therefore reliable indicators of the soil and climatic conditions within the region.

The natural plant growth assists the farmer, especially the dry-farmer, in determining the suitability of the land for agriculture. The sagebrush association indicates a soil suitable for crops and also an amount of rainfall that may permit the production of wheat or barley by dry-farming methods. Practically all of the Oasis bench lands now devoted to grain and orchards were originally occupied by the sagebrush association.

But the presence of sagebrush does not necessarily indicate good conditions for dry-farming. Where the stand is thin and the plants are small and unthrifty, the depth of good soil is too slight for profitable crop production without irrigation. Sagebrush of this character indicates the presence of gravelly hardpan, or else of an excessive quantity of alkali salts, at a depth of only 2 or 3 feet. A good growth of sagebrush also indicates the best land for farming under irrigation. Because of the low water table and the absence of alkali salts, such land is not likely to require artificial drainage.[30]

[30] Kearney, T. H., Briggs, L. J., Shantz, H. L., McLane, J. W., and Piemeisel, R. L., "Indicator Significance of Vegetation in Tooele Valley, Utah," *Reprint from Journal of Agricultural Research*, Vol. I, No. 5 (Washington, 1914), p. 415.

On the other hand, white sage, shadscale and greasewood indicate alkaline conditions and are therefore avoided by the dry-farmers. Shadscale land, when drained, is occasionally tilled under irrigation. The grass-flat land affords pasture to livestock and furnishes therefore a valuable resource. The salt-flat land is too wet and saline ever to be of agricultural value.

SUMMARY

The densest settlement in Utah is found at the western foot of the Wasatch Mountains in Utah and Great Salt Lake Valleys, owing to the natural environment. Favorable conditions of soil, relief and climate induced the Mormons to locate their homes where they have. These same elements have determined the kinds of crops which should be raised. The orchards on the irrigated bench lands, the dry-land wheat on the unirrigated benches, the market gardens and the small farms devoted to sugar beets, corn, potatoes and alfalfa on the irrigated plain, and the dairying on the water-logged lands adjacent to the lakes, all tell their story of the persistent effort to secure a living by making the best possible adjustments to the environmental conditions existing within this physical and economic unit.

III. The Utilization of the Land

An analysis of land utilization in the Salt Lake Oasis, from the standpoint of agricultural geography, involves a survey of the present use, the future development, and the potential value of the region for crops, pasture, and forest.

The area occupied, the land irrigated, and the crop land actually harvested in the Oasis in 1919 are presented graphically in figure 6. The diagram reveals the large percentages under irrigation and in crops. The Oasis comprises some 435,200 acres, 680 square miles, of occupied land of which 93 per cent was irrigated and 84 per cent was in harvested crops in 1919.[31]

[31] The area included within this topographic region comprises approximately 832,000 acres, 1300 square miles, but contains many waterlogged and alkaline lands which are unsuited to agricultural pursuits. The Oasis proper, therefore, is the productive section of this arid waste.

The factors which determine the utilization of the land for crops are: (1) an adequate water supply, either in irrigation streams or as rainfall for dry-farming; (2) suitability of the land for tillage by reason of adequate area and level or gently sloping surface, and (3) the depth of the soils and their freedom from alkaline salts. The suitability of the land for crops is often judged by the natural vegetation.

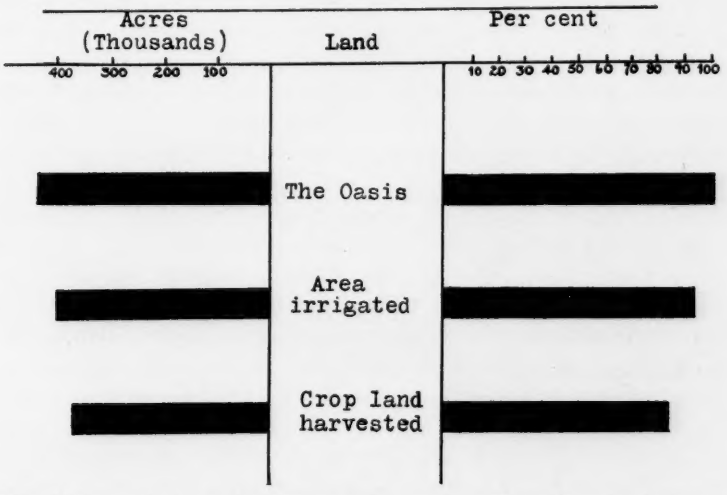


FIG. 6. OCCUPIED AREA, AREA IRRIGATED, AND CROP LAND HARVESTED IN THE SALT LAKE OASIS IN 1919

Various factors differentiate the utilization of this crop land for various agricultural purposes. Areas too rugged for cultivation are left in shrub, grass, or forest, according to their rainfall, and are used for grazing. Benchlands of considerable size, that receive more than 12 inches of rain, but which have inadequate water for irrigation, are generally sown with wheat. But benches under the ditch and with soils of a gravelly nature which drain easily and which are fairly well protected from frost by air drainage are largely devoted to fruit. The irrigated lands in the valleys are used for growing sugar beets, alfalfa, wheat, vegetables, pasture, and occasionally fruit, the utilization for these crops

being determined largely by physical and economic factors. But some valley bottoms are unsuited to the production of peaches, tomatoes, and even corn because of untimely frosts, cool night temperatures, and short growing season.

Of the three possible uses of the land, that for crops is by far the most important. The purpose of this thesis, therefore, is to analyze the present utilization of the land, especially for crops, and to forecast, if possible, the future situation. Agricultural problems of vital significance both to the present generation of farmers and to their descendants as well are now being solved in this region. The details of the present use of the land for crops, pasture and forest appear in sections IV, V and VI. This section presents only a brief consideration of the subject.

PAST CONDITIONS

When the pioneer leaders promulgated Utah's land system, they undoubtedly thought that they had solved one of their biggest problems; and so they had for their day, but not for future generations. They never dreamed that their "home in the wilderness" would have a density of population amounting to 390.7 persons to the square mile; nor did they foresee that their descendants would compete in the sale of their agricultural products in the markets of the world. They anticipated that "Zion" would be an isolated agricultural region, where only self-sufficing farming would be practiced; but this dream was shattered. The ancestral policies of the Mormons are affecting the present generation of farmers in at least two respects: (1) the farms are too small for profitable tillage, and (2) the bulk of the rural population, about 90 per cent,[32] lives in towns and villages, a custom which disadvantageously affects both the utilization of the land and the systems of farming.

THE DEVELOPMENT OF TOWNS AND THE MORMON LAND SYSTEM

The pioneer Mormons called their new home "the Promised Land" for in it they saw the geographic counterpart of Judea

[32] This figure is based upon estimates of county agricultural agents, farmers, and sugar and canning factory field men.

with its Dead Sea, Great Salt Lake, its Sea of Galilee, Utah Lake, its River Jordan, and its deserts and oases. They undoubtedly felt the spell of this situation and were influenced accordingly. For instance, the limited supply of irrigation water made it imperative that the land be held in small parcels if it were to be utilized efficiently, for irrigation required intensive tillage. The need of protection against the Indians and the necessity of co-operative activity in all their irrigation problems profoundly influenced the establishment of the farm villages, now so generally distributed throughout the region. Hardly less important than the environmental influence was that of the Mormon Church. Indeed the conditions which necessitated protection and irrigation lent themselves to the purpose of the Mormon leaders, and served to render permanent the land system inaugurated by the Church. Perhaps in selecting this Oasis for his settlement, Brigham Young "builded better than he knew." Moreover, the encompassing desert discouraged the diffusion of the population into small independent groups beyond the reach of the controlling hand of the Church. The Church leaders realized that they could best retain a grip on their followers by keeping them on the soil. They therefore bent every effort to bring this about. They so discouraged prospecting that minerals were scarcely touched in Utah until 1862, 15 years after the pioneers entered Salt Lake Valley. The Church was also largely responsible for the farm village system. Murray King says: "The Church, the desert, and the canyon stream have conspired to produce village concentration. The Church has created so many religious activities, and so monopolizes social activities that it cannot carry out its program except in organized communities. There is little isolated rural living in Utah. The man who cultivates the soil is the main pillar of a highly structured town life, a life that is indeed tinged with communism."[33]

The method used in founding these settlements is illuminating; it explains the origin of the present social and economic problems of the state. Salt Lake City served as the model for all the infant

[33] King, Murray E., "Utah: Apocalypse of the Desert," *The Nation* (June 28, 1922), p. 769.

settlements. A plot half a mile square, with some 500 or 600 acres of irrigable land about it, was selected as the nucleus for the town site. It is a significant tribute to the value placed upon water by the early settlers that these towns were invariably located on streams. Thus in the survey of any town in the Oasis the principal points or "stakes" from which the lines were run were the streams. For instance that tract between the forks of the Ogden and Weber Rivers in which Ogden is enclosed is described as "commencing at the mouth of Weber Canyon, following the base of the mountain north to Hot Springs, thence westward to the Great Salt Lake, along the southern shore of the lake to a point opposite Weber Canyon, and thence to the point of beginning." "Streets running north and south and east and west were laid out at right angles and at such distances apart as to make town blocks of 10 acres each. A block was divided into eight lots containing approximately one and a quarter acres each."[34] On these were placed the homes, while the farms were located on the outlying lands, which were divided into holdings of from 2 to 40 acres. The town lots were sufficiently large to provide room for a house, outbuildings, a vegetable garden, and a farm orchard. The following description of Provo is given by Stanley Wood:

> This pretty little city belongs to the best type of Mormon towns and a description will serve to give the reader a good idea of the characteristics of all towns built by the Mormons. The dwellings as a rule are comfortable but not imposing in appearance. Many of them are constructed of adobe or sun-dried bricks, and all are situated in lots of generous proportions and surrounded by ornamental and fruit trees. Water for irrigating purposes flows down each side of the streets, and shade trees in abundance and of luxuriant growth render the walks cool and inviting. Gardens filled with fruit, flowers, and vegetables are the rule, and a quiet, peaceful, industrious, semirural life is the good fortune of the residents here. . . . . Provo River furnishes excellent water power, while inexhaustible supplies of artesian water are to be found at a depth of from 40 to 200 feet.[35]

[34] Thomas, George, *Op. cit.*, p. 34.

[35] Campbell, M. R., "Guidebook of the Western United States," *Bulletin 707, United States Geological Survey* (Washington, 1922), p. 233.

PRESENT CONDITIONS

Many of the small pioneer holdings still exist, and in some cases they have been divided and even subdivided among the

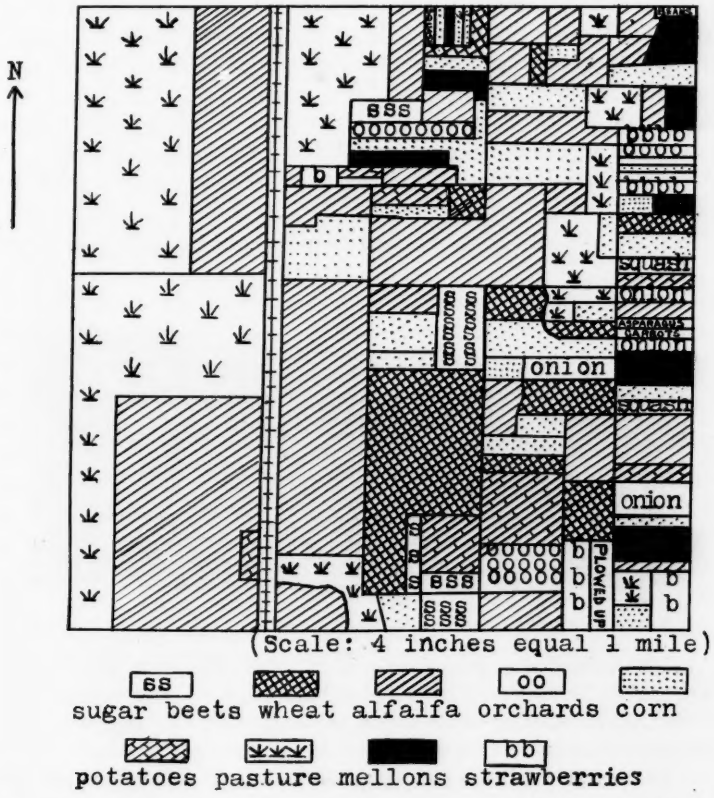


FIG. 7. A DETAILED FIELD MAP TYPICAL OF THE INTENSIVE TILLAGE IN THE CENTERVILLE DISTRICT. SUMMER 1923

heirs. As a result, the farms in the whole Oasis, except in a few recent additions such as the Garland-Fielding district, the Sand Ridge, the Riverton area, and the Provo and Mapleton

Benches, are held in 3, 5, 10, and 20 acre pieces. In every instance this acreage is insufficient for economical cultivation. In order to ameliorate their condition, the farmers have turned from the grain-alfalfa type of farming to a very intensive form of tillage, and are raising sugar beets, tomatoes, peas, beans, potatoes, celery, Spanish onions, head lettuce, cabbage, mellons, and fruit (figs. 7 and 8).

FIG. 8. INTENSIVE DIVERSIFIED TILLAGE EAST OF MURRAY, SALT LAKE COUNTY

With the land area as limited as is at present the case, the problem is to make the most of what is at hand and to grow as much as possible of the most profitable crops which are adapted to the region and its market facilities.

The typical small general operator . . . . therefore, has to concentrate as far as possible on crops which give a high return per acre and on crops which can be marketed locally. As the market for canning crops (tomatoes, peas, and snap beans) is somewhat limited in this area, the Provo, the sugar beet is left as the mainstay for most of these farmers. Many of them specialize on beets, producing little else for sale.[36]

[36] Connor, L. G., "Farm Management and Farm Profits on Irrigated Land in the Provo Area," *Bulletin 582, U. S. D. A.* (Washington, 1918), pp. 23–24.

The same situation prevails in all the older sections of the Oasis. Many farmers have gone into dairying because they were able to purchase tracts of cheap water-logged land, which they use for pasture. Some men have acquired extensive holdings on the benchlands above the ditches which they dry-farm with wheat. Many have bought out their neighbors and combined, thereby making larger units. This accounts for the decrease in rural population in Davis County between 1910 and 1920. At the present time all the choice land, both on the plain and on the benches, is in use. The only available lands lie in the alkaline tracts in the valley bottoms, or on the benches without irrigation water or sufficient rainfall for dry-farming; hence they do not justify reclamation under present economic conditions.

In addition to the handicap of dwarf holdings, the Oasis farmers labor under disadvantages incident to their concentration in towns and villages. Such a system obviously has many drawbacks. Each day during the busy season the farmers lose from one to two hours en route from town to farm. Moreover they are prohibited from many small economies and from conducting subsidiary branches of agriculture which would greatly increase their revenue. They find it impossible to keep livestock and poultry. Occasionally they have a few chickens and a cow in town, but both are a serious nuisance to the neighbors. When they keep a cow, she is put on rented pastures during the day and led home at night by small boy herders. These town-dwelling farmers find it almost impossible to keep sheep and swine. Occasionally they purchase several pigs in the spring which they fatten for home use, but rarely do they rear brood sows. Thus they lose not only the produce from livestock, but the manure which is an asset in farming.

THE UTILIZATION OF THE LAND FOR CROPS[37]

The sugar beet is the principal cash crop of the Oasis. In 1919 it constituted about 25 per cent of the value and about 16

[37] All the percentages under the caption "The Utilization of the Land for Crops" are necessarily based on county figures. But since most of the cropped land in these counties is found in the Oasis, it may be inferred that these percentages represent Oasis conditions to a relatively high degree of accuracy.

per cent of the acreage of all crops. The land selected for beets is always the most fertile on the farm; it is also irrigable and well-drained. Beet culture requires from four to six times as much labor per acre as alfalfa, and therefore returns a profit only if the labor is expended on good soil. Most farmers restrict their beet planting to eight acres, because the farm family, the basic unit around which the farm business is organized, can till intensively only about this acreage without hiring considerable labor during the thinning and harvesting periods. In addition to the labor requirements, beets need sufficient water for irrigation, a mean summer temperature of about 70°F., soils of a sandy loam, loam, or clay loam texture, and land that is nearly level. The cost of hauling beets by wagon is so great that few are grown more than five miles from a factory or beet dump.

Alfalfa is of about the same importance as sugar beets, constituting 27 per cent of the acreage and 24.8 per cent of the value of all crops in 1919. Irrigable, well drained land with a deep water table offer the best conditions for the growth of alfalfa. On farms comprising 50 acres or more, about 30 per cent on the average is devoted to this crop. Favorable physical conditions and the importance of the livestock industry in the region account for the large production of alfalfa. The hay is used in the winter to feed the stock which spent the summer grazing in the national forests. Much is also fed to milch cows, for the Oasis is the dairy center of Utah.

Wheat is raised either on the benches by dry farming or on the plains by irrigation. In 1919 it occupied about 29 per cent of the crop land, and constituted 15 per cent of the value of all crops. Sixty-one per cent of the wheat acreage in the five Oasis counties is dry-farmed. The irrigated wheat is steadily diminishing in acreage and will continue to do so.

Fruit is the leading crop on all the irrigated benchlands, and even on the plain between Provo and Utah Lake. However, the fruit business is being overdone in the region. Many farmers are pulling up their trees and planting the land with alfalfa and sugar beets. The cause for this change is found in high transportation rates and long hauls to uncertain distant markets which

make it difficult for the Utahan to realize a satisfactory profit on his fruit crop.

Vegetables, normally a suburban crop, are raised on the small, expensive farms in the immediate hinterland of Salt Lake City, Ogden, and Provo. Some of the vegetables are consumed locally, some are shipped to distant markets under refrigeration, but most of them are sent to the nearby canning factories.

Pastures usually occupy the sections that are too dry, too wet, too alkaline, and too rough for the production of crops. In 1910 for every 100 acres in farms planted with crops 136 acres were devoted to pasture. In other words 38.8 per cent of the land in farms was in pasture as against 29.4 per cent in crops. Big farms which include extensive pastures develop the dairy industry. The largest dairy farms lie adjacent to Utah and Great Salt Lakes, where much of the land is waterlogged. The pasture land outside farms, however, which is more extensive than that in farms, is utilized for beef cattle and sheep.

The forests are confined largely to the mountains which receive a comparatively heavy rainfall. All these forests are controlled by the Federal Government and are used for timber and for grazing. They are of great value to the Oasis because they prevent spring floods and delay the melting of the snows in the mountains, thereby prolonging the water supply during the summer season.

THE FUTURE CONDITIONS

Agriculture will probably continue to be the dominant activity of the Oasis. Intensive tillage will characterize the region as heretofore, but the miniature farms must disappear, because their labor income[38] is inadequate to meet the needs of the large Mormon families. For instance, only 19 of the 1925 farmers on the Strawberry Valley Reclamation Project in 1922 prospered. On the other hand 668 came out even on the enterprise, 734 lost

[38] The labor income is the amount that the farmer has left for his labor after 5 per cent interest on the average capital is deducted from the farm income. It represents what the farmer earned as a result of his year's labor after the earning power of his capital has been deducted.

money, and 504 did so poorly as to be in actual distress. This condition was due in part, of course, to the national agricultural depression, but the small size of the farms was also a significant factor. In 1914, when conditions were normal, farmers in Salt Lake Valley with less than 20 acres received a labor income of only $139; those with 20 to 50 acres received $308, and those with 50 to 100, 100 to 200, and 200 and more, made $543, $882, and $1198 respectively. These figures tell their own story: farms must comprise at least 50 acres and preferably 100 to 200 acres if the American standards of living are to be maintained. The solution of the problem, however, is by no means easy, because of the high price of the land, the high rate of interest (4 to 8 per cent),[39] and the home instinct of the people. The only logical practice under such circumstances is to rent additional land, in order to enlarge the scale of the farming operations.

IV. Crops

Utah is the only Rocky Mountain State in which agriculture formed the basis of settlement. In all others it was merely an adjunct of mining. Since the pioneers were 1000 miles from the nearest significant white settlements, however, it was imperative that they be self-sufficing. Without food they were destined to starve, for provisions could not be transported over the trackless wastes by ox-cart for so large a number of people, 11,380 by 1850, three years after settlement. The Mormons accordingly became an agricultural folk and have so remained.

Although the physical conditions within the Oasis permit of a large variety of crops, and many are accordingly grown, most of the income is derived from three products, sugar beets, alfalfa, and wheat.

[39] The interest rates on farm mortgages in Utah vary from 4 to 8 per cent, though the latter figure denotes the prevailing rate. Only 6 per cent is charged on money borrowed from the State. L. G. Connor found that the average rate being paid by farmers in the Provo area in 1914 was about 4 per cent.

ALFALFA

Alfalfa is an important Oasis crop, because both physical and economic conditions favor its production. It is grown by nearly every farmer because it (1) provides hay, (2) supplies fertilizer in the form of nitrogen and humus, constituents for the most part lacking in the soils of all arid regions, (3) improves the tilth of the sub-soil as do all deep-rooted crops, (4) requires a small amount of labor for it is not an inter-tilled crop, and (5) provides excellent fall pasturage. Alfalfa invariably increases the yields of subsequent crops, in a rotation series, whether potatoes, tomatoes, corn, wheat, or sugar beets. All the alfalfa raised in the Oasis is fed to livestock within the confines of the state because (1) of the quarantine against it due to infestation by the alfalfa weevil, and (2) of its low value per unit of weight which prevents its being transported to distant markets.

Introduction of alfalfa into America and Utah

Alfalfa probably originated in arid southwestern Asia, although wild forms whence it might have sprung occur in China and Siberia.[40] It was first carried into Europe to provide forage for the horses and cattle of the Persian armies during their invasion of Greece in 490 B.C. The crop, known as Medic clover, was well established in Italy by the first century B.C. Columella, a native of Spain, knew the cultivation of alfalfa or the Medic clover as a conspicuous feature of agriculture in Andalusia in the middle of the first century A.D.[41] From Spain it spread to northwestern Europe, where it was known as lucerne, and to South American and Mexico. It first reached United States territory via northwestern Europe, and was grown by Washington and Jefferson in Virginia and by Livingston in New York, but it did not flourish on account of humid climatic conditions and acid soils. In 1850, however, some alfalfa was taken by gold

[40] "Alfalfa is the Moorish name which the Spaniards brought to America with the forage plant *Medicago Sativa*, Linn., which all over Southern Europe is known by the French name *lucerne*." It means "best fodder."

[41] Harrison, Fairfax, *Roman Farm Management* (New York, 1918), p. 149.

seekers from Chile to the Sacramento Valley, where it met truly favorable conditions. From there seed was transported by Mormon emigrants to the Salt Lake Oasis, where it responded immediately in high acre yields due to favorable soil and climatic conditions and intensive methods of tillage. Alfalfa, which was called "lucern" by the pioneer farmers, outyielded all other irrigated forage crops and so greatly increased the harvests of subsequent crops that it spread rapidly throughout the region. By 1860 it was grown on almost every farm at the western base of the Wasatch.

Rank among Oasis crops

Alfalfa comprised 27 per cent of the crop land harvested and 24.8 per cent of the value of all Oasis crops in 1919. The percentage for the Oasis and for each county is shown in table 5.

TABLE 5

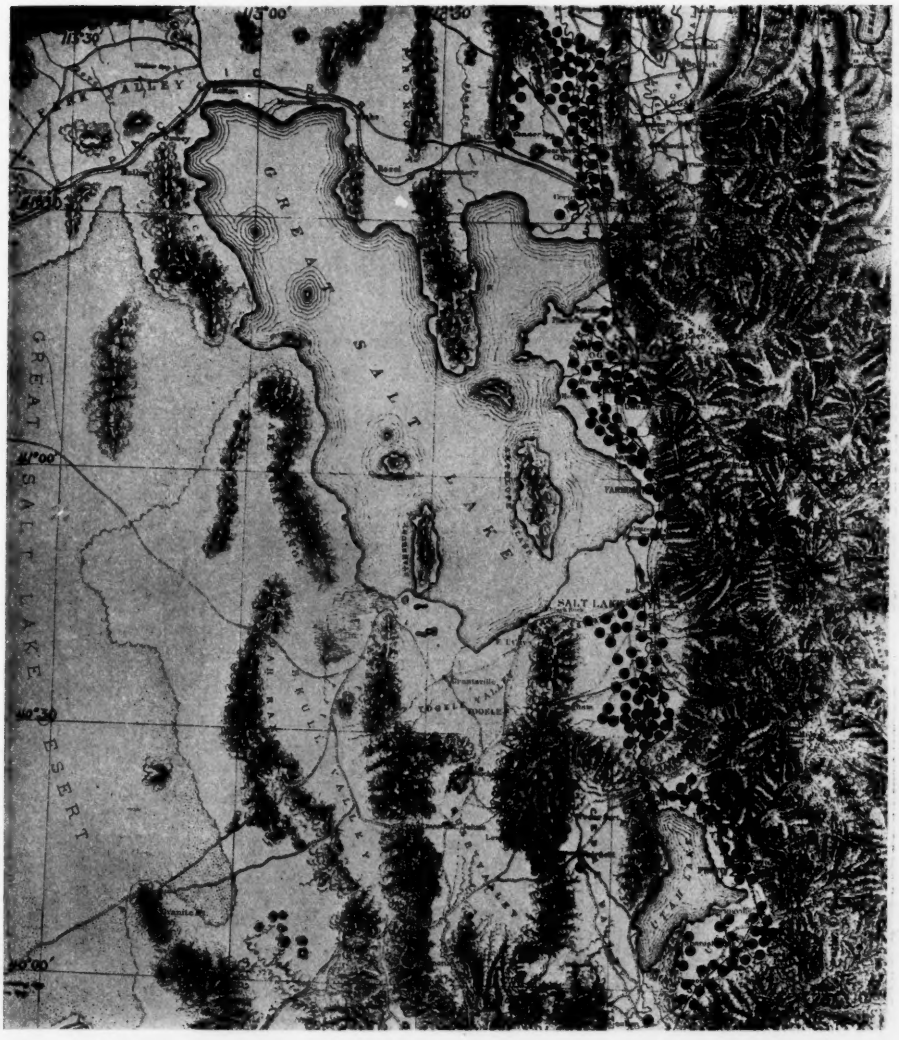
Importance of alfalfa among Oasis crops

COUNTY	YEAR	PER CENT OF CROP LAND HARVESTED	PER CENT OF VALUE OF ALL CROPS	PER CENT OF VALUE OF IRRIGATED CROPS
Oasis	1919	27.0	24.8	
Box Elder	1919	24.4	23.0	45.0
Weber	1919	23.6	19.0	24.7
Davis	1919	30.0	21.9	50.0
Salt Lake	1919	38.1	38.0	64.0
Utah	1919	25.0	22.7	26.0

Distribution

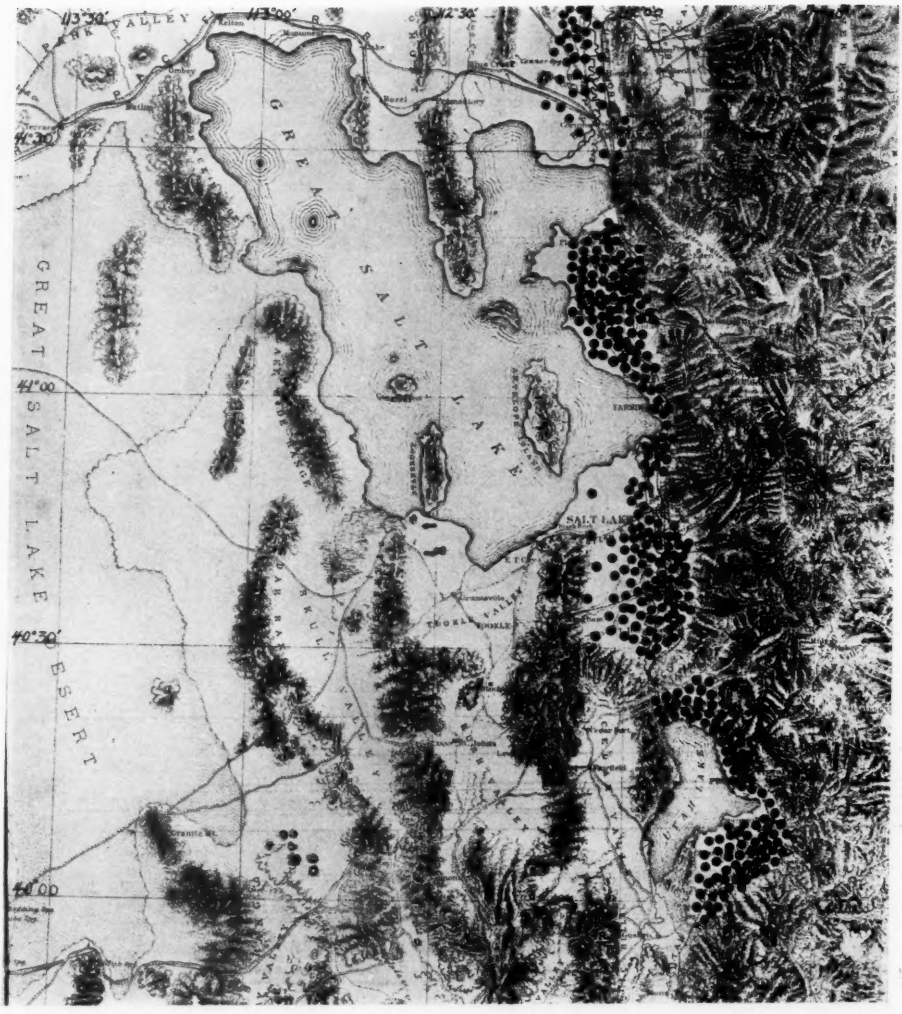
Some alfalfa is grown on nearly every farm in the Salt Lake Oasis. If the maps showing distribution of alfalfa and of farms be superimposed upon the map showing distribution of irrigated land, the three areas will almost coincide (figs. 1, 9, and 10).

Alfalfa is the keystone of Oasis agriculture. Cattle grazing and grain production per se may flourish as ephemeral industries, but eventually they give way to a diversified and somewhat intensified system of farming. Cattle require winter feed; wheat necessarily becomes a part of any plan of rotation; land that is repeatedly sown with wheat soon becomes impoverished



Scale, 23 miles per inch

FIG. 9. DISTRIBUTION OF ALFALFA IN 1919
Each dot = 500 acres



Scale, 23 miles per inch

FIG. 10. DISTRIBUTION OF FARMS IN 1919
Each dot = 25 farms

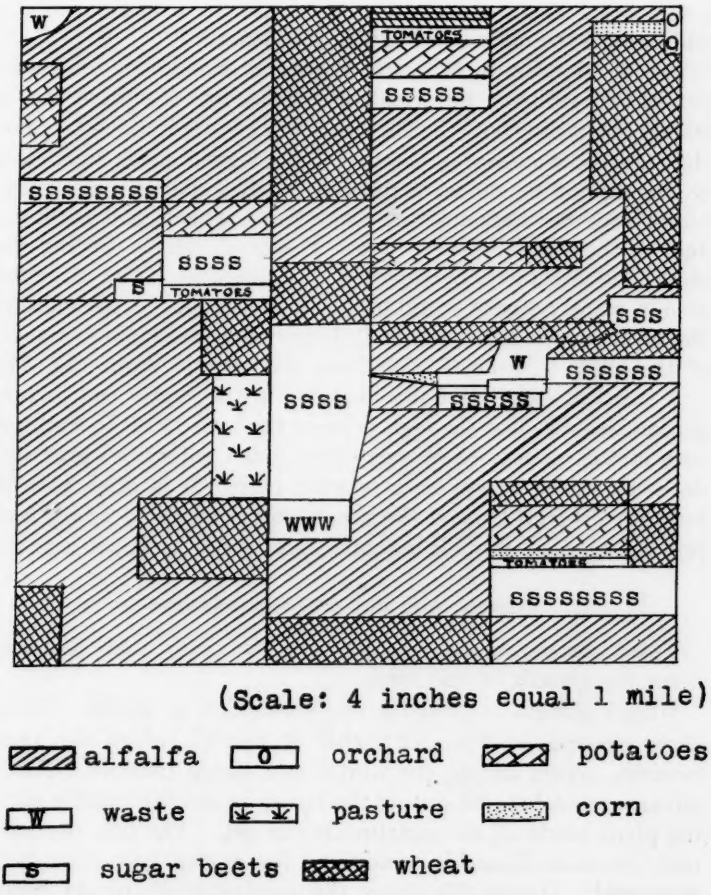


FIG. 11. A TYPICAL AREA, A SQUARE MILE, ILLUSTRATING LAND UTILIZATION WEST OF RIVERTON, SALT LAKE COUNTY, SUMMER OF 1923

The farms here, which are larger than those in most parts of the Oasis, are extensively tilled. Alfalfa and wheat are the chief crops.

and must be replenished. In the Oasis, therefore, or in any portion of the intermontane region, which has soils rich in lime,

a temperate climate, and adequate water for irrigation, alfalfa will become the basis of scientific agriculture.[42]

The distribution of this crop is general throughout the Oasis, yet in two sections, the Fielding-Garland and the Riverton, it stands out prominently. These leave a lasting impression upon the traveler, who sees in the first district great green squares of alfalfa alternating almost as regularly as the squares of a checkerboard with the rectangles of sugar beets, wheat, and potatoes; and in the second district great stacks of alfalfa dotting the plain like mammoth bee-hives in a farm-yard. The Riverton area in many respects is still in the "pioneer stage" of agriculture; the farms which are appreciably larger than those characteristic of the Oasis in general, show less diversity of crops (fig. 11).

A small amount of alfalfa is grown in the truck and market garden sections, but the high price of the land ($500 to $800 per acre in the vicinity of Woods Cross and Centerville) precludes its being raised except as a rotation crop. It is often planted between the fruit trees of the bench land orchards to supply hay, prevent erosion, provide nitrogen, and serve as green manure.

Climate, soil, and drainage relations

Three environmental factors, climate, soil, and drainage, favor the growth of this crop.

Utah's climate is ideal for the production of alfalfa. Sixty-three per cent of the 16.2 inches of rainfall, which the Oasis receives, occurs during the winter and spring months. This is advantageous because during the latter season the rapidly growing plant needs all the moisture it can get. The hot, dry summers provide favorable conditions for curing hay after it is harvested. During this season the growing alfalfa plants receive water by irrigation.

Owing to the scant rainfall, the deep loamy soils over much of the Oasis abound in mineral constituents, and have open porous subsoils, both of which favor alfalfa production. The

[42] Stewart, George, "Alfalfa Production Under Irrigation," *Circular No. 45, Utah Agricultural College Experiment Station* (Logan, Utah, 1921), p. 3.

soil, however, provided it be deep, is less important than climate and drainage, for alfalfa grows on all the better drained soils of the region. The only areas in which the crop fails to thrive are those with impervious subsoils, hardpan, or bedrock near the surface.

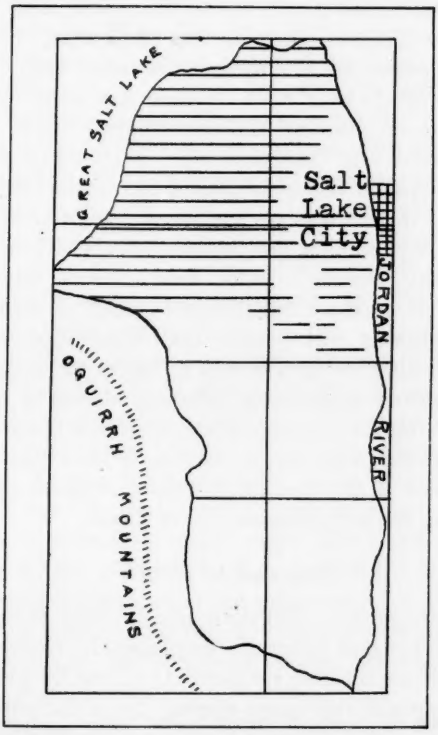


FIG. 12. SKETCH MAP SHOWING DISTRIBUTION OF ALKALI IN SALT LAKE VALLEY WEST OF THE RIVER JORDAN (CLARENCE W. DORSEY)
Horizontal lines cover the area affected

Alfalfa feeds deeply; it commonly penetrates the soil to depths of 6 to 10 feet and under especially favorable conditions even to 20 feet. It thrives only where the surface and subsoils drain well, and where the water table remains at least 4 feet below

the surface. Where the soils become waterlogged on account of seepage or excessive irrigation, the crop loses its dark green color, takes on a sickly yellow appearance, becomes interspersed with weeds, and yields a poor harvest. On these moist lands at the bases of the benches and adjacent to Utah and Great Salt Lakes, wild hay and salt grass grow; where the water table is 4 feet or slightly less, red clover occupies the land, while on the better drained areas, where the groundwater is more than 4 feet below the surface, alfalfa is king of all Oasis forage crops.

Alfalfa grows on alkaline and waterlogged lands, only when these are flooded and underdrained. Such lands in the very heart of the alkaline region of Salt Lake Valley (fig. 12) have been reclaimed in this way on the Swan tract 4 miles southwest of Salt Lake City, and on the property of the Utah Power and Light Company about 7 miles west of the city. Both of these plots now produce satisfactory yields of alfalfa. When economic conditions will justify the reclamation of the vast poorly drained alkaline area shown in figure 12, it probably will be done; no serious engineering difficulty stands in the way, for there is ample fall for drainage north and west towards the lake. Only then will this vast virgin section of level land, which lies at the very door of the best market in the intermontane region, be embodied in the agricultural area of Utah.

Irrigation of alfalfa

Method of irrigation. Flooding alfalfa from field ditches or laterals is the method generally employed in Utah. It is best suited to Oasis conditions, because (1) it can be profitably employed on comparatively steep slopes, (2) in the initial outlay of capital it is one of the cheapest methods, and (3) it is adapted to the delivery of small volumes of water. Concerning the latter point, Deakin remarks that in Utah we find "primitive works supplying small plats of land with little driplets of the precious fluid, out of which, with care and economy, thriving settlements are built up."[43]

[43] Deakin, Alfred, "Different Works in Different States," *Irrigation in the United States, Senate Miscellaneous Document, No. 15, 49th Congress* (Washington, 1890), p. 298.

In grading the land for flooding the surface is transformed only slightly. The smaller knolls are removed and the depressions are filled. An effort is made to have the farm laterals accord with the natural slope and configuration of the tract to be irrigated so as to bring the water to the high places.

Time of irrigation. The time of irrigation varies with the natural conditions. On the semi-impervious loam and clay loam soils, alfalfa is seldom irrigated until June, because till then the spring rains suffice. Irrigation before the first crop is ready to cut only slightly increases the yield. But an intensive application of water just before or just after mowing the first crop and another at the same stage in the second crop gives good results. On the more porous soils, irrigation should take place (1) when the first crop is half grown, (2) just before or just after cutting this crop, (3) when the second crop is half grown, (4) when it is ready to cut or has been cut, and (5) when the third crop is two or three weeks old.

Amount of water required. Alfalfa requires more water than most crops, because (1) it grows rapidly, (2) it produces from three to five cuttings each season, and (3) it yields heavily. Best results are secured when each cutting receives at least one application. It does not necessarily follow, that great quantities of water are more profitable than moderate amounts, for usually the smaller applications yield more abundantly for a given quantity of water. Where land is plentiful and water scarce, it is more profitable to spread the water over a larger acreage and take a smaller yield. This practice involves greater dependence upon the rainfall, the irrigation water serving merely as a supplement.

During normal years, when there is adequate water for irrigation, heavy applications of water are made in order to produce large acre yields. Thirty or 40 inches of water in single amounts of from 3 to 8 inches, applied from two to seven times throughout the growing season, yield from 5 to $7\frac{1}{2}$ tons per acre. The amount of water used, however, depends upon (1) the relative amounts of land and water, (2) the character of the soil, and (3) the seasonal distribution of the water supply.

Alfalfa as forage

Alfalfa produces more feed value per acre than any other forage (table 6). This fact is especially significant in Utah where both alfalfa and livestock are so important and where corn does not thrive on account of the cool nights. Well cured alfalfa is more readily eaten by all classes of farm animals than any other kind of hay and it is more palatable than other legumes such as cowpeas, soy beans, and clover. It is an important constituent in the feeding rations used by all Oasis farmers, feeders, and stockmen, and it enables cattle, sheep, hogs, and poultry to make admirable gains.

TABLE 6*

Returns for an acre of alfalfa and other common forage crops
(Average for the United States, 1899–1909)

CROP	ACRE YIELD	DRY MATTER	DIGESTIBLE CRUDE PROTEIN	DIGESTIBLE CARBOHYDRATES AND FAT	NET ENERGY
	pounds	*pounds*	*pounds*	*pounds*	*therms*
Alfalfa hay	5,040	4,632	529	2,143	1,734
Clover hay	2,580	2,185	183	1,080	896
Timothy hay	2,440	2,118	68	1,106	819
Corn (ears and stover)	3,440	2,604	140	2,110	1,762

* Henry and Morrison, Feeds and Feeding, p. 224.

Alfalfa pastures

After the hay has been removed, it is customary for the Oasis farmers to graze their livestock in the alfalfa fields. In fact some alfalfa is planted solely for pasture. Where growth is vigorous, as in Utah, moderate grazing has no deleterious effects upon the fields. All kinds of livestock thrive on green alfalfa. However, with cattle and sheep there is some danger of bloating, caused by fermentation of the fresh alfalfa which tends to pack tightly. For poultry "lucern" affords a fine green feed rich in protein, and stimulates growth and egg production. Furthermore, in a region nearly devoid of corn, alfalfa pastures furnish a basic feed for swine and are divided and used alternately.

Seed production

Utah produces about 20 per cent of the alfalfa seed of the Union. The Oasis produces only a small fraction of this amount. In contrast, about 75 per cent of the state's seed was grown in the five west-central counties, from 1916–18 inclusive, Millard alone supplying about 40 per cent. The spring season in these counties is earlier and drier and the summer normally a little warmer; therefore the per acre seed yield is greater than in the Oasis. Corinne, roughly representing the Box Elder County seed region, is warmer than Deseret, representing Millard County, particularly in summer, and has greater precipitation, but its yields are less. Farmington, in Davis County, has practically the same temperature conditions as Deseret, but the seed yields are only about one-half as great, due no doubt to the heavier spring and early summer rains.[44]

WHEAT

Wheat is one of the leading crops in the Oasis. Its importance in the region is shown in figure 13. It is both dry-farmed and irrigated. By these methods 64,484 acres and 41,897 acres respectively were tilled in 1919.

Wheat is distributed generally throughout the region. Nearly two-thirds of the acreage is found on the unirrigated bench-lands where the crop is dry-farmed. These benches must be tilled in this manner if they are to be utilized at all. Wheat almost invariably constitutes the initial crop on virgin lands because it (1) is well adapted to the prevailing physical conditions, (2) can be grown easily, (3) entails little cost either for seed or labor, (4) is an almost certain crop, and (5) finds a ready market.

Winter wheat

Winter wheat has been the principal dry-farm crop in Utah, because it (1) is well adapted to the system of alternate cropping and fallowing, (2) meets a steady demand on the Pacific Coast

[44] Alter, J. Cecil, "Alfalfa and the Weather," *Bulletin No. 171, Utah Agricultural College Experiment Station* (Logan, Utah, 1920), pp. 13–14.

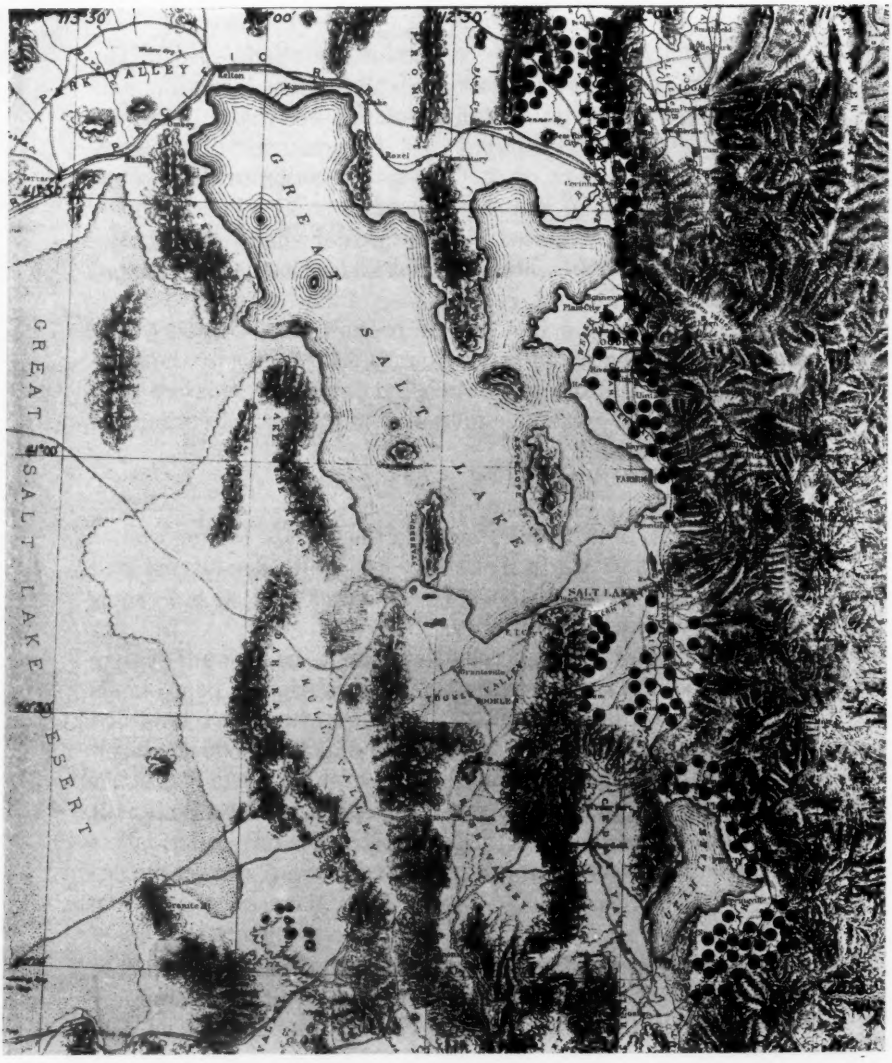


FIG. 13. DISTRIBUTION OF WHEAT IN 1919
Each dot = 500 acres

where it is mixed with the softer irrigated wheat flour and (3) is easily transported from the Oasis to market. Diversification of crops on Oasis dry-farms is practically impossible, because winter wheat is the only profitable crop adapted to the climatic conditions. Therefore, it probably will continue to be the chief dry-farm crop of the state.

Dry-farming in the Oasis. Dry-farming on this continent was begun in the Salt Lake Oasis (page 132). Lack of adequate water for irrigation and the slow development of irrigation projects forced a few of the early settlers to the unwatered bench-lands. Furthermore, the new provision in the homestead law applicable to arid regions enabled farmers to take up 320 instead of 160 acres, and thus added impetus to the dry-farm movement. At the present time (1925) practically all the land suitable for dry-farming has been appropriated.

Response to physical conditions. Bench-lands which in two years get enough rainfall to mature one crop and which are sufficiently level for cultivation are dry-farmed with wheat. Usually this land lies above the ditches or is otherwise so located as to prevent its being irrigated. Much of it has a relatively smooth gradual slope towards the center of the valley. In a few sections, especially in Davis County near Farmington, small hollows occur on the benches. These are left in pasture.

The amount and distribution of rainfall are also decisive factors. About 63 per cent of the annual precipitation, or 10.20 inches, falls between December and June. Much of this, to be of use to the growing plants, must be stored in the soil. Evaporation also enters into the problem, for it determines in a measure, the efficiency of the precipitation. In this arid region evaporation is high, about 50 inches; hence the soil must be retentive of moisture for profitable crop production. Temperature is important because it determines to a large extent the rate of evaporation. The average temperature for the growing season in the region is about 67°F.

Most of the dry-land wheat is produced on those soils which are uniform to a considerable depth, which contain enough sand to make possible easy tillage and enough clay to be retentive of

moisture, and which are unbroken by gravel or hardpan. These soils are always fertile because they have not been leached of their mineral elements.

Land covered with sagebrush is generally selected for wheat because this type of natural vegetation is indicative of fertile soil, excellent drainage, and sufficient precipitation for dry-farming. The heavy shadscale lands or the still heavier greasewood sections are poorly adapted for this cereal and hence are used for other purposes. The natural vegetation is, therefore, of great value in aiding the farmers to choose the most suitable land for crops. Shantz says, "the native vegetation is the integration of all climatic and soil factors, past as well as present."

Farm practices. New land is cleared of brush, burned over, and then plowed in the spring. Old land or "stubble" is plowed either in the fall or the spring. Land to be seeded in the spring is usually plowed in autumn and left rough during the winter. The rough cloddy surface then helps to catch and retain the moisture, and the land "works down" readily in the spring. The results obtained by plowing at depths of 5 to 10 inches have been more satisfactory than those obtained from deep plowing. Spring plowing gives better results and is cheaper than fall plowing "because (1) it eliminates weeds and volunteer grain (which take moisture from the soil) thus reducing the cost of maintaining the fallow; (2) yields on spring plowing are as high as those on fall plowing; (3) land is in better condition for plowing in the spring than in the fall; and (4) average results in the past eight years show that more moisture has been stored in the upper six feet in spring-plowed than in fall-plowed plats."[45]

Summer fallowing has been practiced in the Oasis since the beginning of dry-farming. The fallow land is cultivated once in the early spring, again in summer, and finally just before seeding. The greatest single benefit derived from this practice is the eradication of weeds, which consume so much of the moisture needed by the wheat during the following year; but the maintenance of the soil mulch also helps to reduce evaporation from the

[45] Jones, J. W., and Bracken, A. F., "Grains for the Utah Dry Lands," *Farmers' Bulletin 883, U. S. D. A.* (Washington, 1919), p. 9.

soil. A mulch of small clods is superior to one of fine dust for this purpose, for the latter permits reëstablishment of capillarity in the soil. Autumn seeding, between September 15th and October 15th, produces better results than spring sowing.

Harvesting of dry-land wheat is done in one of three ways: with combines, headers, or binders. Combines are generally used in the Oasis because there is seldom danger from hail, rain, or wind storms; but they demand grain thoroughly ripe. South of the Oasis, however, especially on the Levan Ridge, headers replace these large machines.

Varieties and yield. Several varieties of winter wheat are grown in the Oasis, but Turkey Red, a hard red Russian variety, predominates. In addition Gold Coin and Koffoid wheats are important. The latter are beardless, white-kerneled and soft. They are produced by farmers who prefer them to Turkey Red because they are easier to handle and can be used for feed. In 1914 the yield on 24,617 acres of winter wheat was 22.6 bushels per acre.[46] In 1923 the acre yield on the experimental farm at Nephi was about 30 bushels; this was slightly higher than that secured by the majority of farmers in the same region. Some men, however, get as much as 55 bushels per acre.[47,48]

Spring wheat

Spring wheat in the Oasis is grown mostly on irrigated land; on dry-farmed benches it is a minor crop, and in most cases serves merely as a filler where fall wheat has been winter-killed, for in comparison with the latter it is not profitable on the dry farms. The average yields of Turkey Red under dry-farming conditions amount to more than twice those of the leading spring wheats. Spring varieties seldom are grown where winter varieties are successful.

Just as spring wheat is ill adapted to dry-farming conditions on

[46] *State of Utah, Third Report of the State Bureau of Immigration, Labor and Statistics* (Salt Lake City, 1917), p. 60.

[47] Paxman, J. W., "Dry Farming an Important Agricultural Asset," *Ibid.*, p. 103.

[48] Mr. D. B. Broadhead and Mr. Isaac H. Grace, both of Nephi, customarily get from 50 to 55 bushels of Turkey Red to the acre.

Oasis benchlands, so is winter wheat to irrigation conditions on the plain. Winter wheat is not suitable for use in any rotation system on irrigated land. During the fall when it would require labor, the farmers are busy picking and delivering tomatoes, peas, and peaches, and digging and hauling sugar beets. The period June–November inclusive is one of assiduous labor; but in

TABLE 7*

Cost of production and returns per acre from principal three crops on Strawberry Reclamation Project†

	SUGAR BEETS			WHEAT			ALFALFA		
	1920	1921	1922	1920	1921	1922	1920	1921	1922
Cost:									
Production	$72.25	$58.55	$44.00	$36.30	$26.14	$21.21	$16.45	$13.20	$9.85
Hauling and shipping	12.30	9.10	7.30	1.14	0.81	0.87			
Total per acre	84.55	67.65	51.30	37.44	26.95	22.08	16.45	13.20	9.85
Returns:									
Average gross value per acre	149.40	63.85	69.40	53.30	23.55	26.90	51.6	33.75	24.25
Net return:									
Gain	64.85		18.10	15.86		4.82	35.15	20.55	14.40
Loss		3.80			3.40				

* Courtesy of W. L. Whittemore, United States Reclamation Service, Provo, Utah.

† The Strawberry Reclamation Project is situated in Utah County, along the southeastern shore of Utah Lake. It serves a dual purpose in furnishing a full supply of water for about 20,000 acres, as well as a late supply for about 35,000 acres of land in the vicinity of Spanish Fork, Springville, and Mapleton, which were previously inadequately supplied during the months of July, August, and September.

September, October, and November the tasks multiply. During October, when labor is at a premium, the schools often close to allow the teachers and pupils to help with the beet harvest. Therefore, it would not be profitable under such conditions to add the burden of sowing winter wheat.

Wheat is the least profitable of the crops grown in rotation on the highly productive irrigated land; hence the question naturally arises, as to why it is produced (table 7). The reasons are that

TABLE 8*

Labor requirements per acre for wheat (7 typical growers)

Yield 50 bushels an acre

OPERATIONS	PERIOD	DAYS		CREW		ACRES PER 9 HOUR DAY	TIMES OVER	HOURS PER ACRE	
		In period	Available for field work	Men	Horses			Man	Horse
Clean ditches	March 1 to May 1	61	35	1	—	6	—	1.53	—
Fit	March 1 to May 1			1	2	2½	—	3.60	7.20
Sow	March 1 to May 1			1	2	10	—	.20	1.80
Harrow	March 1 to May 1			1	2	12	—	.72	1.53
Water furrow	March 1 to May 1			1	2	15	—	.63	1.17
Irrigate	May 1 to July 1	61	42	1	—	6, 7 & 10	3	3.15	—
Cut	July 1 to September 1	62	50	1	3	9	—	.99	2.97
Shock	July 1 to September 1			1	—	5	—	1.80	—
Stack	July 1 to September 1			1	2	5	—	1.80	3.60
Stack	July 1 to September 1			2†	—	—	—	3.60†	—
Thrash	July 1 to September 1			1	15	—	—	.63	—
Thrash	July 1 to September 1			6†	—	—	—	3.60†	—
Plow	November 1 to December 1	30	20	1	2	1½	—	6.03	11.97
Total								28.98	30.24

* Bulletin 165, Utah Agricultural Experiment Station

† Extra labor.

it (1) fits into the rotation as generally practiced, (2) is a cash crop, (3) supplies feed for poultry, and (4) equalizes the seasonal requirements for labor.

Table 8 shows that spring wheat occasions no conflict in labor with fruit, tomatoes, sugar beets, and other important cash crops. It is sown about the middle of April, because it requires some cool weather during its early growth in order to tiller properly.

Method of irrigating. Flooding is the method generally employed to irrigate wheat. As in the case with alfalfa, the operation takes place from field laterals. Small ditches are run across the field in such a way as to permit the water to flow to all parts.

Time of irrigation and amount of water required. The time to apply water to wheat can be best determined by noting the color of the blade. If insufficient water is used, the crop becomes dark green and the leaves droop during mid-day. Plants that receive sufficient moisture have a bright verdant color and the leaves seldom droop, unless the weather becomes excessively hot. Most of the Oasis farmers, however, can tell when water is needed by feeling the soil immediately below the surface. It pays best to irrigate the deep lacustrine Oasis soils when planted with wheat about three times during the season. Irrigation should begin when the plant is from six to eight inches high and should be discontinued about the time it is in blossom. About five inches of water should be applied each time.[49] If only one irrigation can be given, then the water should be applied at the five leaf stage. This is the case on several of the benches along the Wasatch especially near Farmington, Draper, Lehi, American Fork and Santaquin, where the farmers utilize the water in the small streams until they dry up in July. When two irrigations are possible, the five leaf and the boot stages are the most advantageous periods.

Yield and variety. The leading spring varieties are the Dicklow, New Zealand, and Turkey, though unfortunately there is a great deal of mixing on Oasis farms. This has resulted in great

[49] Harris, Fred, "Irrigation of Wheat," *Bulletin No. 146, Utah Agricultural College Experiment Station* (Logan, Utah, 1916), p. 29.

losses to the farmers because it has reduced market grades, lowered yields, and shrunken the heads on account of variations in the time of maturing.

The Dicklow, a Utah Wheat, is very important in the Oasis. A farmer in Utah County obtained some California Club wheat from Northern California and sowed it on his farm. He met with such success that he gave some to a neighbor, Richard Low. The latter grew it, and noticing that it contained different types proceeded to select that which he deemed the best. After several years of persistent effort he obtained such enviable results that the whole County began to cry for "Dick" Low's wheat. As the variety became distributed throughout the Oasis and the intermontane region, it lost its personal connection with Dick Low and became known as Dicklow wheat. It is a soft, white wheat with a compact and beardless head of medium length. It has a good stiff straw, is of medium height, and stands up well under irrigation.

The per acre yield on 13,856 acres harvested in 1914 was 32.26 bushels. While this amount is 9.66 bushels higher than that secured on the dry-lands, it does not warrant the planting of wheat in large amounts on the expensive irrigated farms.

SUGAR BEETS

Sugar beets constitute the one really reliable cash crop in the Salt Lake Oasis. In contrast to such variable cash crops as fruits, vegetables and grain, the farmer can tell in advance approximately what his beet acreage will net him, for (1) he may be reasonably certain that his crop will not suffer from environmental causes providing he maintains a rational system of rotation, (2) he knows the per acre tonnage of his land, and (3) he contracts for his beets with the sugar companies at a stipulated sum per ton. Sugar beets in turn yield a manufactured product which can stand transportation costs to distant markets; the average yield of an acre of sugar beets, 2500 pounds of refined sugar, can be shipped from the intermontane country to Chicago for approximately $17.50, whereas it costs about 6 times as much to transport the yield of an acre of potatoes, and about

3 times as much for an acre of alfalfa. This is especially significant because the bulk of the Western cash crops must be sold in distant markets. Only eleven per cent of the sugar produced in Utah, for instance, is sold locally.

The environmental factors operating in the Oasis are as advantageous to beet production as the economic factors. Temperature, the greatest single factor determining the sugar content of beets, is ideal, averaging about 67°F. for the growing season. Light frosts, which contribute to the sugar content in beets, generally occur at night during the time of harvest. Abundant sunshine, a paucity of strong winds, and a long frostless season averaging 142 days are all pertinent climatic factors. The deep sandy loam, loam, silt loam, and clay loam soils of the Oasis are admirably adapted to the growing of this crop. Finally, an adequate supply of water for irrigation is available in all the beet growing sections.

Place of the sugar beet in Oasis farming

No crop is more significant in Oasis agriculture than the sugar beet. It serves admirably as a cash, rotation, intertilled, and feed crop. Seventy-five per cent of the farmers raise beets, though only 16 per cent of the irrigated land is devoted to beet culture. This fact is easily explained, however. The average beet plot is relatively small when compared with that in alfalfa because it must be intensively tilled. In 1923 individual beet plots averaged in size: 5.6 acres in Weber County, 8.3 in the Layton section, 10.8 in the vicinity of Brigham City, and 8 for the Oasis as a whole. The amount of irrigated land devoted to beet culture varies widely in the different counties, according to the statistics of 1919. It constituted 28 per cent in Davis County, 21 per cent in Weber, 15 per cent in Box Elder, 15 per cent in Utah, and 7 per cent in Salt Lake County.

Since Utah is so far from the more important markets, it is imperative that the farmers raise crops which have relatively high value per unit of bulk and which can be profitably exported. The cost of railroad carriage for such commodities as alfalfa, potatoes, wheat, and fruit from Utah is becoming almost prohibi-

tive on account of the high freight rates. Many Western farmers look upon the reduction of these rates as the one panacea for their ills, but in this they err. Their one hope is to raise diversified crops and raise mostly those which can be transported in a concentrated form. Many of the farmers who have been devoting their efforts to the growing of one crop such as grain or fruit are meeting with heavy financial losses. Consequently they are pulling out their fruit trees and planting sugar beets and alfalfa, crops which can be transported in the concentrated form of sugar and meat. So important have the returns from sugar beets become to the Oasis farmer, that beet money is synonomous with "tax money."

Besides the factors mentioned above, several others are worthy of note. Utah has more sugar beet factories than any other sugar producing state, averaging 1 for each 11 miles of length in the Salt Lake Oasis. This distribution has encouraged production, because beets must be raised relatively near factories. In order to shorten still more the length of haul of the farmers, the sugar companies have constructed numerous beet-dumps along the railroads wherever production has justified their erection. (A dump will be built in any district which grows a minimum of 320 acres of beets). So important have the dumps become that less than 10 per cent of the beets of the Oasis are delivered to the factories by the farmers. Most of the roads to the dumps are good, and it may be appropriately said at this point that the beet growing sections have the best roads in the state.

Development of the industry in Utah

Utah is among the pioneer American states in the production of sugar beets. The first sugar factory was erected in 1852 at Sugar House, now a part of Salt Lake City. This establishment, however, like all others during the early days was unsuccessful. In 1891 a factory was erected both for cutting and refining beets at Lehi in Utah County. At that time only two other American factories were refining beet sugar. Now, 1923, Utah has more beet sugar factories than any other state in the Union, surpassing by one Colorado, which has eighteen establishments. Twelve of Utah's factories are in the Salt Lake Oasis.

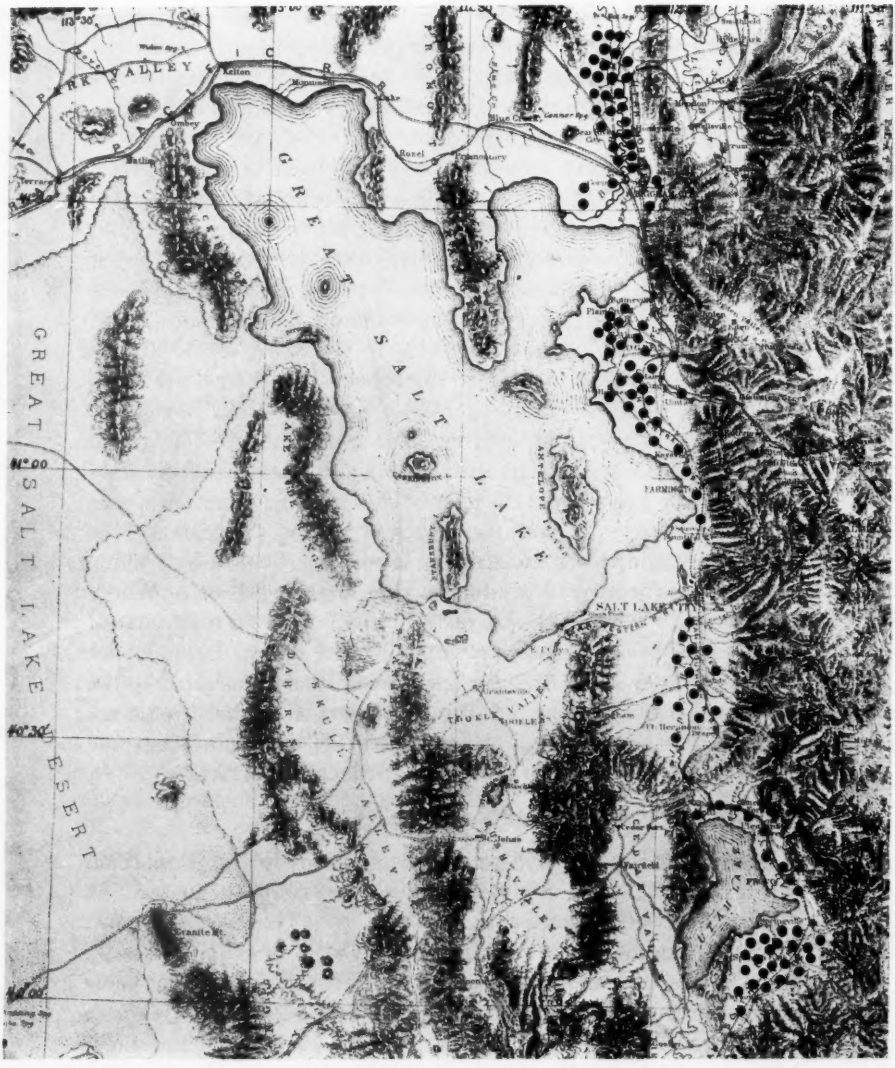


FIG. 14. DISTRIBUTION OF SUGAR BEETS IN 1923
Each dot = 500 acres

Distribution

Sugar beets are distributed quite generally throughout the Oasis (fig. 14). They are grown preferably, however, in the best watered areas and in those that have small farms. Davis County, which leads in the amount (28 per cent) of its irrigated lands devoted to beets, also has a larger percentage of small farms per area than have Box Elder, Salt Lake, Utah, and Weber Counties. Inasmuch as this crop requires very intensive cultivation, it is significant that the better beet producing sections are those where the farms average from 10 to 20 acres. A notable, exception to this is the land in Bear River Valley near Garland, Riverside, and Fielding, where several thousand acres are owned by the Utah-Idaho Sugar Company, which also owns the Bear River Canals, the best in Utah. This land is rented in large plots to tenants, many of whom are Japanese and hence well trained in intensive tillage.

Most of the sugar beets in the Oasis are grown on the heavier soils of the valleys, but not to the exclusion of such benchlands as the Sand Ridge and the Provo and Mapleton Benches. However, where beets occur on the elevated lands, they are produced only where the soils are free from stones and gravel, and where there is adequate water for irrigation. The only two well-watered benches are the Mapleton Bench, which benefits from the great Strawberry Valley Project, and the Sand Ridge, which is well supplied from Cozy Dale to Clearfield by the Davis and Weber Counties Canal.

But it must not be thought that the distribution is wholly a question of adaptation to natural conditions; for a factory at hand is necessary for profitable beet production. This crop cannot be raised on isolated farms; it must have sufficient acreage to justify the erection of a factory near-by.

Adaptation

As a result of thousands of experiments Dr. Harvey W. Wiley has demonstrated that with a given quality of seed, summer temperature is the dominant factor regulating the sugar content

of the beet. Whenever the temperature during the frostless season goes above 70 or 72 degrees, the sugar content decreases. While soil fertility and moisture influence tonnage, their effect is slight upon sugar content. The Salt Lake Oasis, with an average temperature for the growing season of about 67°F., is admirably adapted to the production of this crop.[50]

Though the amount of rainfall in the Oasis is insufficient to produce beets, there is generally adequate water for irrigation, which can be applied to the beets just when they need it and in just the amounts most favorable to their development. A detailed treatment of irrigation, however, will be found in the latter part of this chapter.

Strong winds are fatal to the production of sugar beets in areas where the soil is of a sandy nature. The wind blows the sand, thus riddling and burying the young beets with shifting particles. In the Oasis there are a few sandy areas especially around the edges of the valleys, but these are avoided by beet growers and factory field-men alike, because of the prevalence of winds. They also increase the amount and rate of evaporation from the soil. For this reason a given amount of moisture in soil swept by hot dry winds during the spring is much less effective in crop production than the same amount of moisture in a locality where such winds do not occur.

The deep lacustrine soils of the Salt Lake Basin are especially well adapted to the growing of this crop. The only ones on which beets do not thrive are the thin, stony, gravelly bench soils, and the waterlogged or alkaline valley soils. A deep soil that can be penetrated readily by the expanding roots affords the best conditions. The sandy loams, loams, and silt loams are preferred by the beet growers in the Oasis, because they have given the highest yields. Since beet culture entails considerable expense, the thrifty farmer ventures upon it only where climate and soil are favorable.

[50] This average was taken for typical stations in the area—Corinne, Ogden, Farmington, Lehi, Provo, and Spanish Fork.

Rotations

The sugar beet enters into the rotation system of most Oasis farmers. The rotations, of course, differ somewhat according to (1) soil type, (2) climate, (3) proximity to factories or beet dumps, (4) the most profitable crops of the section in question, (5) the relative acreage to be devoted to beets, (6) the amount of fertilizer available, (7) the number of livestock kept on the farm, (8) the presence of pests, and (9) the size of the family; for in Utah children and women do much of the hand labor, very little being done by Mexicans and Japanese as in many beet growing sections of the United States.

Certain crops such as beets, alfalfa, grain, potatoes and special canning crops (tomatoes, beans, or peas), enter into nearly all the rotations in this area. "A farmer with 80 acres of land wishing to raise 20 acres of beets and having as other possible crops, alfalfa, potatoes, tomatoes, peas, beans, and small grains might arrange his crop rotation something like this: (1) alfalfa four years followed by potatoes, corn, or tomatoes one year,[51] beets one year, peas or beans one year, beets again one year, grain as a nurse crop with alfalfa one year. This would give an 8 year's rotation with the following acreage for each: alfalfa 40 acres; corn, potatoes, or tomatoes 10 acres; beets 20 acres; peas or beans 10 acres; and wheat, oats, or barley 10 acres."[52]

Many of the irrigated farms, however, comprise less than 80 acres, the average probably being from 10 to 25. The same general arrangement is adopted, however, except that the relative area planted with beets is larger. Where alfalfa does not thrive, as in areas adjacent to the lakes, where either the land is excessively wet or saline, clover or wild hay is substituted, though wherever alfalfa can be grown, it is the preferable forage crop in a beet rotation. Where one of these other crops is grown, however, good yields of beets are secured only with the application of manure prior to planting the crop.

[51] Few Oasis farmers follow alfalfa with beets because of the interference of the crowns and plants that are not killed.

[52] Harris, F. S., and Butt, N. I., "Sugar Beet Production in Utah," *Circular No. 34, Utah Agricultural College Experiment Station* (Logan, Utah, 1918), p. 7.

Preparation of the seed bed and planting

Sugar beet land is usually plowed in the fall, because frequent winter and spring rains prevent early spring plowing. Fall plowed land absorbs considerable moisture and responds readily to freezing and thawing, which together put the soil in the best physical and chemical condition for beet production. It favors early spring planting and relieves the rush of spring work. Furthermore, it allows deep penetration of moisture in sufficient quantities to favor the growth of long beet roots, thereby insuring a larger yield.

Deep plowing is the rule here because the expanding beet roots require a loose soil, and because this practice tends to eradicate many injurious fungus and insect pests. The depth varies from 10 to 20 inches, though most farmers plow to a depth of 10 to 15 inches.

Plowing is followed by tillage methods because the seed bed must be put in condition favorable to the quick germination of the seed and the rapid growth of the young plant. This means that the surface soil should be mellow and fine and at the same time firm and moist. Moreover, since the beet field is to be irrigated, the land must be leveled, the high points worked down, and the depressions filled; for otherwise in some places beets will suffer from lack of water, and in others from excessive moisture.

The seed is planted between May 15th and May 20th.[53] It finds a warm, damp soil most favorable for rapid germination and refuses to sprout in a dry soil. Usually it is placed from three-fourths to one and one-half inches deep. Shallow planting is preferred, especially on the heavier valley soils. About 15 pounds of seed are used per acre, if the soil has been well prepared. The distance between the rows varies from 18 to 30 inches, though 20 inches is the average distance, since it is wide enough for horse-drawn cultivators.

[53] Baker, O. E., and Brooks, C. F.. "Seedtime and Harvest," *Circular 183, U. S. D. A.* (Washington, 1922), p. 44.

Thinning, hoeing, and cultivating

Cultivation begins as soon as the beet rows can be distinguished, because early tillage conserves moisture, checks the growth of noxious weeds, and aerates the soil and the roots of the tiny plants. Later when the beets have become established, they are blocked. This is done by hoeing out all plants except bunches from 8 to 12 inches apart. When the beets have developed 4 to 6 leaves, these tufts are thinned, and only the sturdiest plant is left. This operation is a most important one for it influences greatly the tonnage of the yield and therefore the net profit which the farmer makes on his crop. Thinning is a task which must be done with the hands, because the roots are so close together that no machine can be used without injury to the plants. At this stage in the cultivation, the farmer, busy with other work, finds it necessary to employ his own family or to hire boys to do the thinning.

Two hoeings by hand are necessary. They must be well timed because their purpose is to eradicate the weeds before they have stolen the nourishment and moisture from the young plant. These hoeings should be thorough. This is more essential with a crop like sugar beets than with one like corn, which rapidly grows tall and soon overshadows the weeds. In the beet field, the weeds do the shading. Sugar beets are cultivated every 10 days so as to keep down all weed growth and to maintain a mulch over the surface of the ground. This process is continued until the leaves get so large as to be injured by the cultivator.

Irrigation

Practically all of the Oasis beet fields are watered by the furrow method of irrigation. The amount of water to be applied at each irrigation varies locally with such environmental factors as sunshine, rainfall, wind, and type of soil, especially its depth and texture, which determine its power to hold moisture. An irrigation of about 5 inches just before thinning, another when the roots are about 2 inches in diameter, and a third when the beets are nearly ripe, making a total of about 15 inches, give best results

in the Oasis.[54] Since the beet is a deep rooted crop, the moisture must sink as far down as the roots penetrate. Where the soil is suitable, a few rather heavy irrigations are conducive to larger yields than are numerous small ones.

As regards the time to irrigate, this is known intuitively by most farmers. Much damage has been done to the Oasis beet crop heretofore because of the fallacious ideas that (1) water should be withheld in the spring until the beets begin to suffer and (2) that irrigation should be discontinued 5 or 6 weeks before harvest; but now the farmers realize that if the plant suffers from lack of water either early or late in the season the yield will be appreciably reduced.

There is a tendency in all the beet-growing districts to over-irrigate, despite the advice of the field experts who are employed by the sugar companies to aid in the growing of the crop. An evidence of this practice may be seen in the yellowish appearance of the beet leaves over much of the area.

Pests and diseases

Most Oasis soils were originally well adapted to the growing of sugar beets. Large yields were obtained and the farmers made money. They therefore continued to raise beets on the same field year after year without any rotation whatsoever. This practice fostered the widespread introduction of pernicious pests which have eliminated whole districts from beet culture. The agricultural superintendent of one of the larger Utah factories stated that despite the fact that his company had insufficient acreage under contract to meet economic needs, nevertheless it would have been unwise to contract for more, because of the ravages of pests, especially the sugar beet nematode. He said, moreover, that rotations were needed badly in all the beet growing sections. For example an economic survey party found on the Strawberry Valley Project in 1922 that of the 1925 farmers, 1208 were following a systematic plan and diversification of crops,

[54] Harris. F. S., and Butt, N. I., "Thirty Years of Agricultural Experiments in Utah," *Circular No. 46, Utah Agricultural College Experiment Station* (Logan, Utah, 1921), p. 12.

while 717 (37 per cent) were repeating the standard crops without apparent reference to good farming or good market conditions. In 1923 the ravages of the nematode were in evidence in every section save three—the Riverside-Garland-Tremonton, the Layton, and the Mapleton. Nematode infested areas are characterized by spots in each field which produce no beets or only a few undersized ones. Where sections are severely infested, the beets wilt and wither just after thinning and often all but a few die.

The nematodes are spread over the sugar beet areas in a number of ways. Cultivators, levelers, and harrows drag particles of infested soil to uninfested parts of the field; irrigation water carries many of the cysts and deposits them along the furrows where new colonies of the insect soon become established. Many nematodes are transported on the feet of livestock from field to field and from farm to farm. Probably the worst distributing agency of this dreaded pest is the beet dump, which returns to the farmers the dirt from the beets just delivered. Some of the soil from an infested area sticks to the screens, and is not jarred loose until another load of beets is dumped. Often the land of the second farmer has not been infested with nematodes heretofore. In this manner farmers receive infested soil, take it to their fields, and scatter it, thinking that they are getting good fertile soil.

So far only one way has been devised for eradicating the nematode and that is by means of crop rotations. "A successful rotation is as follows: wheat or oats as a nurse crop for alfalfa. The following spring allow the alfalfa to grow about one foot high, then plow it under and plant potatoes. The next year grow beets and then repeat the rotation."[55]

Harvesting

When the lower leaves of the beet plant turn brown, lose their vigor, and take on a drooping appearance, and when the upper foliage becomes somewhat yellow, the beets are mature.

[55] Thorne, Gerald, and Giddings, L. A., "The Sugar Beet Nematode in the Western States," *Farmers' Bulletin, 1248, U. S. D. A.* (Washington, 1922), p. 15.

The sugar companies which contract for the beets reserve the right to say just when the crop shall be dug. Samples taken at random throughout the fields by the factory field men are tested by chemists for sugar content and purity. As soon as a sufficient number of fields show beets of proper quality, that is beets with more than 12 per cent sugar and a purity coefficient of 80 or more, orders are given and the beets are harvested and delivered to the factories or dumps. It is necessary that the factories determine the time of delivery rather than the farmers, because the former employ both expert agriculturists and chemists, whose advice is reliable. Many individual farmers would be influenced more by personal convenience than by the actual condition of the beets. They fail to realize that the last few weeks of growth are often the most critical, for at this time the larger percentage of the sugar is stored and the tonnage is often materially increased. During the early stages of its growth the plant is spending its energy on roots and leaves, and it is only when growth has been completed that the plant begins to store sugar in appreciable amounts.

Beets are harvested by mechanical devices and by hand. When the work is done by hand, the general method, it is necessary to lift, pull, top, pile, and haul them. Lifting the beets consists in loosening them with some sort of implement, so that they can be pulled easily. After they have been pulled they are topped, and the roots thrown into piles, from which they are loaded on wagons by means of blunt-tined forks.

Topping is an important operation, and unless properly done results in considerable loss both to the farmer and the sugar company. The cut should be made at the sun line, which is indicated by the coloring in the part of the beet that protrudes above the surface of the ground. If the beets cannot be hauled to the dump or factory after topping, they are generally covered with beet tops, straw, or earth to prevent freezing and evaporation. Earth makes the best covering.[56]

[56] Harris, F. S., and Butt, N. I., "Sugar Beet Production. . . . .," *Loc. cit.*, p. 22.

Yield

The average yield per acre in Utah in 1920 was higher than that of any state in the Union—12.35 tons. The 1922 per acre yields for the different factories operating within the Oasis were as follows:

	tons per acre
Brigham City	12.5
Garland	12.5
Hooper	10.55
Layton	13.7
Lehi	12.5
Ogden	13.6
Payson	10.5
Spanish Fork	10.25
Springville	12.6
West Jordan	12.5
Average for Oasis 1922	12.12

The largest yields per acre are secured on the small farms of the intensively tilled sections. In contrast low yields are obtained on the large farms of the extensively tilled districts. The lowest yield is received in the Spanish Fork-Payson section, where wheat is the predominant crop and in point of acreage exceeds the beets three to five fold. Wheat removes more fertility from the soil than any other product and hence impoverishes the soil for the later beet crop. The beet yield is low in the Riverton district, where the ranches are large, because, (1) the farmers cannot till intensively, and (2) the majority of the farmers live in town, and therefore lose too much time going to and from their farms. No irrigated crop needs more attention than the sugar beet. Hard work and high per acre yields usually go hand in hand. Some Oasis farmers get from 20 to 30 tons per acre, but they are in the minority.[57]

Relation between beet culture and stock rearing

Cattle, hogs, and sheep are valuable adjuncts to all sugar beet districts. They contribute greatly to the economic success of

[57] John Bancroft and John Dreyer of Clinton, Utah, customarily get from 20 to 30 tons of beets per acre. In 1922 they harvested 22 and 25 tons respectively.

Oasis agriculture. The keeping of stock enables the beet grower to make the best possible use of the beet tops, otherwise an economic waste, to buy beet pulp, which is a nutritious cheap feed, and to restore to the land in the form of manure the plant food which has been extracted from the soil.

Seasonal requirements for labor

The farmers who raise sugar beets give this crop first consideration in the amount of labor to be expended, and in selecting other crops they choose those which will not interfere with beets in their seasonal demand for labor. Though the labor requirement for beets is heavy, it extends over a long period, often from March to November inclusive. It occasions no conflict with any important field crop except tomatoes, and even then only in the districts which specialize in canning tomatoes—Tremonton, Brigham City, Ogden, Roy, Murray, Riverton, Orem, Pleasant Grove, Provo, and Springville. This conflict is not serious except when considerable amounts of both beets and tomatoes are grown. Tables 9 and 10 show the labor requirements for sugar beets and tomatoes in the Provo area.[58] Only the thinning and harvesting periods require more labor than the farmer and his family can supply. It is then necessary to secure additional help. Since more than 75 per cent of the Oasis farmers raise beets, a dearth of man labor prevails. Therefore during the harvesting period it is customary in the little farm villages to close the schools for a period of several weeks and employ the pupils and teachers.

Beet raising and community welfare

No crop has had as great an influence for good in western agriculture as the sugar beet. Beet culture is not conducive to slip-shod farming. The beet cannot be raised unless careful attention is given to every operation from plowing to the delivery of the crop at the factory. The expense of producing beets is so great (from $40 to $50 per acre) that the farmer cannot afford

[58] Connor, L. G., "Labor Costs and Seasonal Distribution of Labor on Irrigated Crops in Utah Lake Valley," *Bulletin No. 165, Utah Agricultural College Experiment Station* (Logan, Utah, 1918), pp. 14 and 15.

TABLE 9*

Labor requirements per acre for sugar beets (13 typical growers)

Yield 20 tons an acre

OPERATIONS	PERIOD	DAYS		CREW		ACRES PER 9 HOUR DAY	TIMES OVER	HOURS PER ACRE	
		In period	Available for field work	Men	Horses			Man	Horse
Manure	Winter	92	46	1	2	½	—	18.00	36.00†
Clean ditches	March 1 to May 1	61	35	1	—	6	—	1.53	—
Plow	March 1 to May 1			1	2	2½	—	3.60	7.20
Fit	March 1 to May 1			1	2	2½	—	3.60	7.20
Plant	May 1 to July 1	61	42	1†	2†	10	—	0.90†	1.80†
Harrow	May 1 to July 1			1	2	12	2	1.53	2.97
Cultivate	May 1 to July 1			1	2	8	4	4.50	9.00
Block and thin	May 1 to July 1			1	—	1	—	9.00	—
Block and thin	May 1 to July 1			3†	—	—	—	10.80†	—
Hoe	May 1 to July 1			1	—	1	—	9.00	—
Cultivate	July 1 to September 1	62	50	1	2	8	1	2.25	4.50
Irrigate	July 1 to September 1			1	—	6	5	7.47	—
Weed	July 1 to September 1			2†	—	3	2	6.03†	—
Harvest‡	September 1 to November 1	61	42	1	2	⅘	—	11.25	21.60
Harvest‡	September 1 to November 1			4†	3†	—	—	45.00†	33.75†
Plow	November 1 to December 1	30	20	1	2	1	—	9.00	18.00
Total								143.46	142.02

* Bulletin No. 165, Utah Agricultural Experiment Station, p. 14.

† Extra labor: Blocking and thinning and weeding done by boys, reduced to man hours.

‡ A part of the harvest often extends into the next period.

Note: Subsequent enterprise studies in this area (U. S. D. A. No. 693) have shown that it requires 130.8 man hours and 117.14 horse hours to produce an acre of sugar beets. These amounts are somewhat below the totals that are given in table 9. However, it should be borne in mind that 58 records were used in the former case, whereas the above table is based on 13 records. The reported acre-yields are also 1¼ times larger in table 9 than those in the enterprise studies.

TABLE 10*

Labor requirements per acre for tomatoes (5 typical growers)

Yield 18 tons an acre

OPERATIONS	PERIOD	DAYS		CREW		ACRES PER 9 HOUR DAY	TIMES OVER	HOURS PER ACRE	
		In period	Available for field work	Men	Horses			Man	Horse
Manure	Winter	92	46	1	2	⅔	—	13.50	27.00
Clean ditches	March 1 to May 1	61	35	1	—	6	—	1.53	—
Hot bed	March 1 to May 1			1	2	2	—	4.50	1.80
Cold frame	March 1 to May 1			1	2	2	—	4.50	1.80
Weed and water frames	March 1 to May 1			1	—	1	½	4.50	—
Fit	March 1 to May 1			1	2	1⅔	—	3.87	7.83
Fit	May 1 to July 1	61	42	—	—	—	—	1.53	2.97
Weed and water frames	May 1 to July 1			1	—	1	½	4.50	—
Furrow	May 1 to July 1			1	1	10	2	1.80	1.80
Transplant	May 1 to July 1			1	1	1	—	9.00	9.00
Transplant	May 1 to July 1			1*	—	—	—	9.00†	—
Reset	May 1 to July 1			1	—	8	—	1.08	—
Cultivate	May 1 to July 1			1	1	4	3	6.75	6.75
Irrigate	May 1 to July 1			1	—	6	2	2.97	—
Hoe	May 1 to July 1			1	—	1	1	9.00	—
Cultivate	July 1 to September 1	62	50	1	1	4	3	6.75	6.75
Irrigate	July 1 to September 1			1	—	6	4	6.03	—
Hoe	July 1 to September 1			1	—	1	2	18.00	—
Weed	July 1 to September 1			1	—	—	1	2.25	—
Harvest and haul ½ crop‡	July 1 to September 1			1	2	—	—	18.00	24.03
Harvest and haul ½ crop‡	July 1 to September 1			12†	—	—	—	54.00†	—
Harvest and haul ½ crop	September 1 to November 1	61	42	1	2	—	—	36.00	47.97
Harvest and haul ½ crop	September 1 to November 1			12†	—	—	—	108.00†	—
Plow	November 1 to December 1	30	20	1	2	1	—	9.00	18.00
Total								336.06	155.70

* Bulletin No. 165, Utah Agricultural Experiment Station, p. 17.

† Extra labor: Weeding done by boys, reduced to man hours.

‡ Picked at 4½ a box, largely by boys, girls and women. Time reduced to man hours.

to neglect any phase of the work. The hauling of beets requires good roads and good horses, and both are to be found in the Salt Lake Oasis.

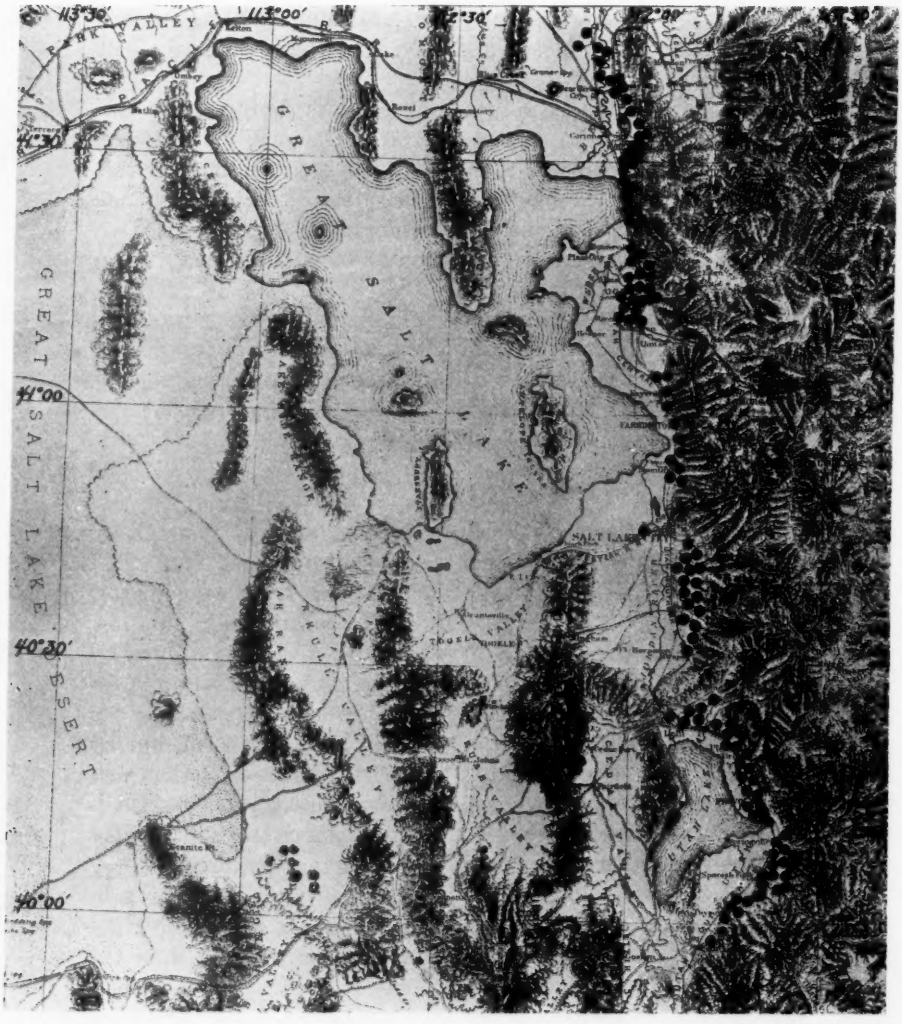
The sugar factories employ many farmers during the "campaign," October 15 to January 15. One factory, for instance, employs 275 farmers for about 90 days each season. If this number were to be employed by each of the 12 factories operating in the area, it would mean that employment would be had for a period of approximately three months by 3300 farmers, in an otherwise idle season.

With sugar beets as an important crop, less acreage per farm is required to make a living than where grain and hay are grown. This means that sugar beet culture promotes a denser population, which is both advantageous and disadvantageous. It helps to solve a real problem in Utah, however.

Fruit

The bulk of Utah's fruit is produced in the Salt Lake Oasis. Seventy-eight per cent of the acreage of the small fruits and seventy-seven per cent of the orchard fruit trees were in this region in 1919. The geographic distribution of fruit, (fig. 15), although determined largely by physical factors, is restricted by economic factors. The amount of land physically suitable for fruit production is much larger than the utilized area; for the crop is determined not by the possibility of production, but by the probability of consumption. The fruit industry of the Oasis is overdone, a situation realized by many prominent Utah agriculturists. Consequently the State Experiment Station encourages a diversified rather than a specialized system of farming.

Physical factors for the most part favor fruit production in this region. The temperature for the growing season averages about 67°F. and the frostless season 142 days, varying from 182 days at Salt Lake City to 115 days at Midvale. Abundant sunshine characterizes most of the growing period. The air drainage on the bench lands is excellent and the gravelly soils promote rapid water drainage and enable the ground to warm up quickly in the spring, thereby advancing the frostless season. The fruit



Scale, 22.8 miles per inch

FIG. 15. DISTRIBUTION OF ORCHARD FRUITS IN 1919
Each dot = 10,000 trees

growing sections on the plain lie adjacent to water bodies which mitigate the risk of killing frosts. The insufficient precipitation is supplemented by irrigation.

The economic conditions for fruit production are unsatisfactory. The local markets, limited in number, are customarily glutted during the harvest season. Consequently the farmers must depend upon a distant and uncertain market. The predicament of the peach grower especially is critical, for his crop competes in the Eastern market with that from the Michigan Fruit Belt. Obviously the Michigan grower has a big advantage over the Utah horticulturist, since his cost of production and marketing is notably less. His crop must be a failure or of poor quality before the Utah grower can make a satisfactory profit.

Utah Lake Valley

Approximately one-third of the fruit of the state and one-half of that of the Oasis is grown in this valley which comprises about one-fourth of the tilled land of the Oasis. The stone fruits are confined largely to the bench-lands, while the apples and pears apparently are better adapted to the heavier soils of the lacustrine plain. The principal districts of this valley include the Provo and Mapleton Benches and the plain between Provo and Utah Lake.

This wonderful fruit region has evolved during a long period of development. A few trees were planted by the pioneers shortly after their arrival, but it was not until 1883, 33 years after settlement, that car-lot shipments moved from the valley. The pioneers were extremely tenacious of their tradition of raising wheat, hay, and corn. The first fruit, principally apples, was grown on the plain, and the upward march onto the bench-lands, where optimum conditions of climate and soil prevailed especially for the stone fruits, was slow and vacillating. This movement came through crowding rather than bold experimentation. But even so it took genuine courage for these farmers to move onto the gravel benches. In many respects the situation resembles that of the Scotch-Irish frontiersmen on the prairie and woodland sections of Illinois, who clung so steadfastly to the forest lands.

Many people laughed at the Mormon farmers who early bought at $2 per acre the coarse gravel land, now the choice Provo Bench fruit district.

Physical conditions in this valley favor fruit culture. The orchard lands comprise two classes: (1) the apple and pear orchards of the plain, and (2) the peach, cherry, apricot, and prune orchards of the elevated lands. The plain with its loam and sandy loam soils offers favorable conditions for apples and pears, despite the fact that the water table lies only from two to four feet from the surface. Practically none of these orchards are irrigated from canals; seepage from the heavily irrigated lands above and water from numerous artesian wells being sufficient. Though these orchards are on the plain, danger from killing frosts in early fall and late spring is diminished by the proximity of Utah Lake, which covers an area of about 93,000 acres. Though Utah Lake has an elevation 281 feet higher than that of Great Salt Lake, the temperatures of the two valleys are about the same, owing to the fact that Utah Lake Valley slopes towards the south.[59]

The bench-lands, which border almost the entire crescent of Utah Lake Valley, owing to the numerous streams which break through the Wasatch enroute to the lake, are fairly well supplied with irrigation water. Of the two large benches, the Mapleton and the Provo, the former gets a copious supply of water because it comprises a part of the Strawberry Valley Reclamation Project, but the latter receives insufficient water with the result that many farmers are obliged to pump their supply from wells. These elevated sections are also favored by good air and water drainage, shadow protection, suitable soils, and a long frostless season.

The color and quality of the fruit grown in this region are excellent, because of the ideal sunny climate and the water of the cold mountain streams which can be applied as needed to insure optimum development. Fruits grown at high altitudes keep extraordinarily well and lend themselves to cold storage.

[59] Hinton, Richard J., *Op. cit.*, p. 51.

Salt Lake Valley

For convenience the fruit lands of this Valley will be divided into districts of concentrated acreage and production. However, it should be borne in mind that fruit is grown on practically all the bench-lands and in several places on the plain.

South Salt Lake district. The factors which favor the production of fruit in this area include (1) a copious supply of irrigation water obtained from the Jordan and its numerous tributaries which emerge from the Wasatch at this point, (2) the long growing season, 182 days at Salt Lake City, (3) the fertile and for the most part well-drained soils, especially east of the Jordan, (4) air drainage on the benches, (5) shadow protection of several hours per day afforded by the Wasatch and Oquirrh Mountains, and (6) the local markets provided by Salt Lake City, the smelting centers of Midvale, Murray, Magna and Garfield, and the mining camps at Bingham, Alta, Park City, etc.

The influence of elevation on climate and consequently on the kinds of crops raised has been worked out as a practical problem for two contrasted areas in this district.[60] East Mill Creek on the bench, about seven and one-half miles southeast of Salt Lake City and Wandamere, on the plain, 2 miles west of East Mill Creek, have elevations of 4450 and 4250 feet respectively. Amazing differences exist between the cultural landscapes of these two places. East Mill Creek produces both vine and tree fruits, while Wandamere of necessity confines its efforts to the growing of vegetables, grain, beets and hay. The berry vines and fruit trees at the former place are evidence of its advantage in an early spring over its neighbor, for the growth of these crops depends primarily on warm atmospheric temperatures. The drainage of cool night air into the Wandamere bottoms causes a pronounced lag in the arrival of spring, and gives a lower mean 24 hour temperature than at East Mill Creek. The slope between the two places is gradual. Therefore the 200 foot rise, representing two weeks difference in the length of the frostless season, may be fairly accurately divided into units of one day

[60] Alter, J. Cecil, *Op. cit.*, pp. 314–316.

earlier for fruit for each 14 foot rise from Wandamere to East Mill Creek. This would amount to a difference in the daily spring mean temperatures between the two places of about four and two-thirds degrees F.

No fruit trees hug the lake in this district as in Utah Lake Valley, for adjacent to Great Salt Lake the poorly drained land contains excessive amounts of alkali. Moreover, Utah Lake is a fresh water body, while Great Salt Lake is one of the most saline lakes in the world, and is bordered by soils less fresh and loose than those of its neighbor to the south.

Kaysville-Farmington-Bountiful district. This area embraces a large part of Davis County, especially the bench-land. At present only a small part of the region naturally adapted to orchards is actually devoted to horticulture because of the lack of a good market and of adequate water for irrigation. The bench-lands receive irrigation water from the several small intermittent streams, which emerge from the mountains, while the plain gets its supply chiefly from artesian wells. While this section receives more rainfall than any other in the Oasis (20.67 inches at Farmington) it has a deficient supply of water for irrigation, because the mountains to the east have restricted catchment basins for the snows that fall during the winter. Consequently, irrigation from streams ceases here in July. As on all the benches, air and water drainage are excellent and alkaline lands are absent except on the plain adjacent to Great Salt Lake. The soil is largely a mountain wash. Cherries, peaches, and grapes constitute the chief fruits raised in the vicinity of Kaysville. Peaches predominate near Farmington. From this point south to Bountiful market gardening and truck farming occupy most of the land though considerable vine and tree fruits are grown. In the Farmington-Bountiful strip, where miniature farms prevail, Utah's most intensive agriculture is practiced. From this area much small and some tree fruits are shipped East in car load lots, sold to passing autoists[61] and peddled in Salt Lake City, and the nearby smelting and mining towns.

[61] Stands of fruits and vegetables largely operated by the children of the growers, are to be found during the summer in front of nearly every farm house on the state highway in this district. Much fruit is sold in this manner.

Ogden district. Excellent orchards dot the benches in the Ogden and North Ogden district. The chief portion is undoubtedly the "Sand Ridge," a strip of the old delta of the Weber River which extends from the Globe Mills in Ogden south to about Clearfield in Davis County, west to the railroad tracks and east to the valley of the Weber. It is utilized for fruit, however, only when there is adequate water. The lands above the ditch are devoted to the growing of dry-land wheat or are left as waste.

Most of the fruit grows on the sandy and fine sandy loams adjacent to the mountains. These soils usually contain small to medium gravel within three feet of the surface; for many years after settlement they were considered too coarse for apple and pear orchards, but by recent experiment they have been proved suitable. Prior to the construction of the Davis and Weber Counties Canal, however, this whole area was covered with sage brush and sun-flowers, except isolated sections farmed with dry-land wheat.

The water used in this district comes chiefly from the Weber and Ogden Rivers, though some is derived also from North Ogden Canyon and numerous springs which issue from the base of the Wasatch. In addition flowing wells are extensively utilized.

Probably no district in the Oasis is better suited for fruit production than this one, owing not alone to its excellent natural conditions, but also to the distinct economic advantages which it enjoys. Its proximity to Ogden, the second largest city in the state with a population of 32,804 (1920), the most important railway center in the intermontane country, as well as the chief canning and milling center, affords it an excellent outlet for fruit. Lands in orchards with bearing trees have a valuation from $600 to $1000 per acre.

Brigham City-Perry-Willard district. This district with Brigham City as its nucleus constitutes the peach center of the state. Brigham, sometimes called Peach City, because of its location amid extensive, beautiful, and well-kept orchards, alone shipped 467 cars of this fruit in 1913.

This district in common with all oasis bench lands, is favored

in fruit production by various physical conditions—by gravelly soils, air drainage, freedom from alkaline salts, excellent water drainage, and shadow protection. On the other hand, the water supply is inadequate because of the small number of streams, Box Elder Creek, being the only one worthy of mention. Consequently "about 400 acres of land beyond the reach of ditches from the canals are irrigated by a score or more of wells pumped by electric motor."[62]

Garland-Tremonton district. This apple district located in the northern part of the Oasis in the eastern portion of Box Elder County lies on the loamy soils of the lacustrine plain west of the Malade River. It enjoys good drainage which prevents the harmful accumulations of alkali common in the area slightly to the south on the same type of soils. The soil contains considerable lime. The district has an annual rainfall of 11.62 inches, but gets on the average only 2.99 inches from June to October inclusive, the season when crops require the greater part of their moisture. Irrigation therefore is necessary. Abundant sunshine gives a rich color to the fruits of this section. Spring frosts seldom injure the buds, though fall frosts sometimes cause slight damage. The average date of the last killing frost is about May 15th and the first in the fall is October 7th.

Night irrigation, which characterizes the less-watered sections of the Oasis, is not practiced here, because this section receives a copious supply of irrigation water from the Bear River, the largest in the region.

Air drainage is good despite the fact that the orchards are on the plain. This is accounted for by the fact that the Bear and the Malade Rivers have cut deep gorges into the deltas which they deposited during the time of ancient Lake Bonneville. As the lake receded Bear River gradually cut into its own deposits until now the channel is entrenched below the plain to a depth ranging from a few feet at Corinne to about 150 feet where the river breaks through the Wasatch from Cache into Salt Lake Valley. Malade River has cut a channel from 10 to 50 feet

[62] Lee, Willis T., and others, *Guidebook of the Western United States, Part B., The Overland Route, U. S. G. S., Bulletin 612* (Washington, 1915), p. 107.

below the plain. The cool air tends to collect in these lower places and hence little harm is done to the orchards.

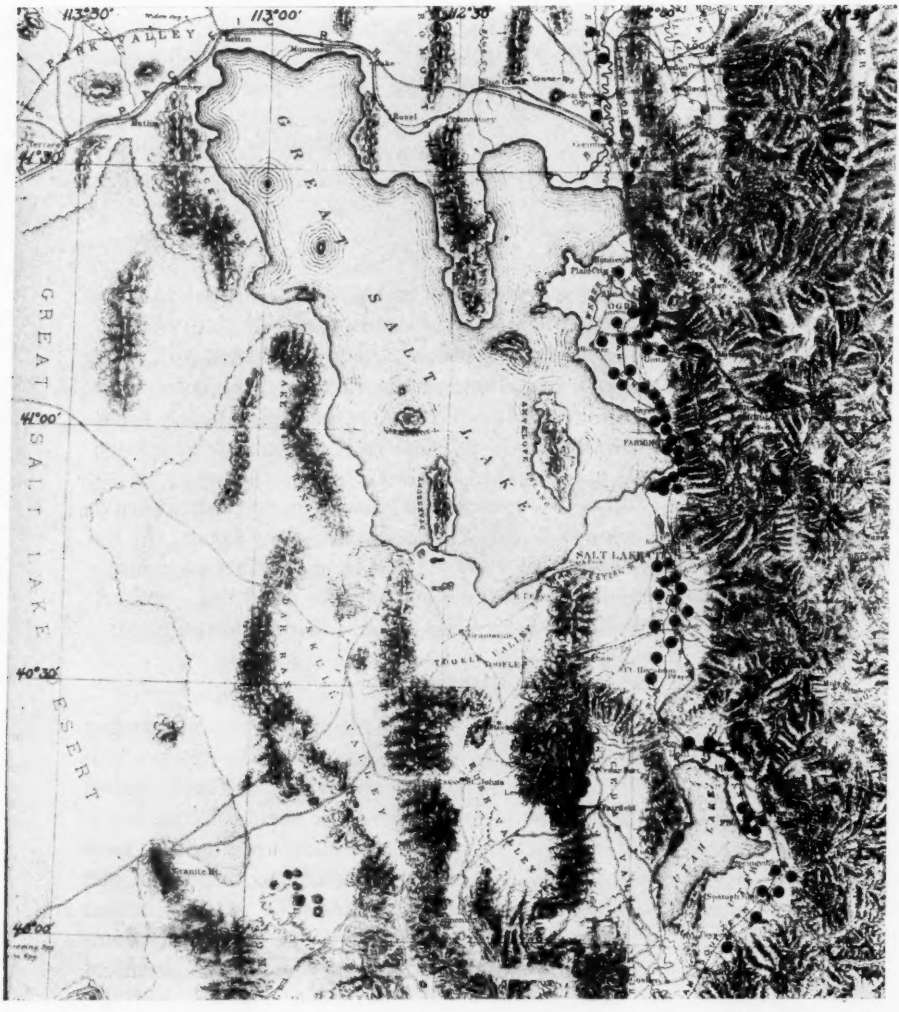
Heavy yields have been obtained from the trees in this area, but in recent years, owing to the lack of good markets and the prevailingly low prices paid for the crop, many farmers have uprooted their trees and are raising the more reliable crops, alfalfa and sugar beets. Dairying is also becoming increasingly important.

VEGETABLES

Two-thirds of the acreage devoted to vegetables in Utah are found in the Salt Lake Oasis, which comprises less than one per cent of the total area of the state; eighteen per cent of the vegetable acreage, mostly in the form of market gardens, is found in Davis County, chiefly between Farmington and Woods Cross (fig. 16). The factors, both physical and economic, which favor the production of vegetables in the Oasis are (1) the long growing season, (2) the large number of sunshiny days, (3) the extensive areas of sandy loam soils, (4) the small size of the farms, (5) the high cost of the irrigated land, (6) the large number of canning factories, (7) the excellent transportation facilities, and (8) proximity to the best local markets in the intermontane region.

Distribution

Vegetables are grown under three different systems of farming —home gardening, market gardening, and truck farming. The first type is distributed over almost the whole of the irrigated Oasis, since nearly all the farmers raise some vegetables for home consumption. The market garden sections are located near the cities, where the farmers can drive daily to dispose of the produce. The truck-farms are closely allied with the distribution of canning factories; in fact their development on a truly commercial scale was made possible largely by the establishment of these factories, because prior to their advent, wheat and alfalfa occupied most of the crop land. However, the truck-farms do not sell all their produce to the canneries. They ship a considerable amount under refrigeration to various parts of the country,



Scale, 23 miles per inch

FIG. 16. DISTRIBUTION OF VEGETABLES IN 1919
Each dot = 200 acres

though only the costly, fancy varieties such as celery, tomatoes, cauliflower, Spanish onions, and head lettuce can stand the long haul to distant markets.

Tomatoes

Since 1888, the year in which the canning industry was introduced into Utah, tomatoes have been one of the principal Oasis vegetables. They are grown mostly for the canners, who contract for them at a definite price per ton—$10.00 in 1923. Many carloads of fresh tomatoes are also shipped from the state as shown in table 11. Tomatoes, therefore, rank with sugar beets as a cash crop, though owing to their extreme sensitiveness to frosts and hail, their production is much more precarious than is that of sugar beets, whose physical requirements are notably

TABLE 11

*Carlot shipments of tomatoes from Utah, 1917 to 1921 inclusive**

STATE	1917	1918	1919	1920	1921	5-YEAR AVERAGE
Utah	229	633	475	251	100	338

* Compiled from telegraphic and mail reports made by division superintendents and agents of all the railroads in Utah.

less exacting. Tomatoes are sensitive to climatic conditions; hence they are confined to restricted areas where they can enjoy both a long growing season without frost and at the same time command the economic advantages of a good market.

The crop is grown from Tremonton in Box Elder County to Springville in Utah County, but the heart of the area is Ogden. Here natural and economic factors have united to promote the production of this crop. The "Sand Ridge" and the North Ogden Bench (remnants of deltas built during the Bonneville period by the Weber and Ogden Rivers) rise several hundred feet above the plain and hence are protected by air drainage. The average growing season is about 163 days, or 10 days to two weeks longer than that in the surrounding valley; this extra period, free from frost, is often responsible for doubling the yield and consequently the net income from the crop. The better tomato

soils comprise the sandy loams, which are warm, well-drained and easily worked.

The economic factors are almost equally important. Chief of these is proximity to Ogden. This city, by reason of its strategic location at the mouth of Weber River Canyon, which forms the one real break in the Wasatch barrier, has become a busy railroad center. It is now the collecting and distributing point within the intermontane region. The Ogden railroad facilities stimulated the concentration of canneries in this area; there now being 15 in the immediate vicinity of the city, many of which use tomatoes exclusively. The concentration of canning factories here means that the distance of haul from farm to factory is relatively short, a very important factor, because no other crop demands such a minimum of handling as the tomato. This crop like beets, requires good roads, which are found in this area. Tomatoes hauled over rough stony roads, inevitably are in bad condition upon their arrival at the factory and often are rejected.

The amount of labor demanded by tomatoes is little less than that required by beets. Consequently few farmers raise both crops. The seeds are sown in hot beds about April 1st; the small plants are transplanted to the field between May 10th and June 1st. The picking season generally extends from August 15th to about October 15th. Numerous cultivations are required between these dates. The first occurs immediately after the plants have become established in the field. When the young vines are planted, the soil surrounding them sometimes becomes packed and causes them to wilt. Irrigation rejuvenates them. They are then cultivated deep and close to the plant. All subsequent cultivations become gradually more shallow and are farther away from the plant. This method keeps a dust mulch over the ground and thus retards evaporation. It is customary in the Ogden area to work the tomato fields twice a week for the first three weeks, and once a week thereafter, until the plants become too large for working without injury to the fruit.

The period of tomato harvest is one of the busiest seasons of the year for the farmers, who pick, sort, load, and deliver their crop. While these operations require much time, the delay which

frequently confronts the growers at the factories involves great waste of time. Few canneries are capable of handling the loads as rapidly as they arrive and frequently 25 or 30 wagons are lined up waiting to be unloaded. Farmers are often obliged to wait from three to seven hours. This naturally exasperates them at the period when the demand for labor is at its peak.

The white farmers who raise tomatoes seldom contract for more than eight acres. Some of the Japanese laborers, however, who lease farms often grow from 15 to 25 acres, and some individuals undertake as much as a 40 acre contract. Under such circumstances they raise little else, whereas the Mormon farmer probably has also crops of alfalfa, wheat, oats, and perhaps tree fruit. The average per acre yield of tomatoes for the Oasis in 1923 was 10.5 tons. The yield on the farms supplying some of the factories, however, was higher, those supplying the Utah Canning Company being about 15 tons. Individual farmers produced higher tonnages, many reporting yields of 30 to 35 tons.

Peas

Utah peas are almost as important in the canning industry as tomatoes, the output being 741,389 cases in 1922 as compared with 779,129 cases of tomatoes. Much of the pea crop, however, is grown outside the Oasis in the cooler, moister valleys of the Wasatch. Two of the leading pea canneries are located at Morgan in Morgan County and Smithfield in Cache County. Other pea growing and pea canning sections are found in the Oasis near Tremonton, Ogden, Murray, and Provo.

The growing of this crop is increasing because of the predominance of the dairy and beet industries in the Oasis. Since peas are leguminous they fit into these systems of farming admirably because they add nitrogen to the soil, thereby increasing the yield of the subsequent crop, and the vines make excellent stock feed. Furthermore, peas do not conflict in their demand for labor with any of the major Oasis crops, because they are harvested from July to September, prior to other intensively-tilled crops.

Celery

Celery has not been extensively grown in the Salt Lake Oasis but its future prominence seems assured. It is well suited to Oasis conditions where the atmosphere is dry, sunshine abundant, and where the days are warm and the nights cool. The warm days with plenty of sunshine give rapid growth and tender celery; the cool nights make solid crisp stems. Injurious diseases and insects do not thrive in this dry climate. In some of the lower portions of the valleys near the lakes, are areas of muck soil, rich in humus, which are ideally suited to the growth of celery, for the product is crisp, tender, and of delicious flavor.

The principal producing areas lie in Davis, Salt Lake, Weber, and Utah Counties. Small portions of the market gardens in the Farmington-Centerville-Bountiful-Woods Cross district, the muck lands south of Salt Lake City, and the moist sections in the Provo and Ogden districts are devoted to this crop. Until quite recently, most of the celery was grown by Chinese gardeners in the vicinity of Salt Lake City and Ogden to meet the local demand. But owing to its excellent quality and an effective marketing organization, many native farmers are able to ship their product East and West. The only gardeners who devote their acreage almost wholly to celery are the Chinese; the Mormons raise it merely along with numerous other vegetables.

Spanish onions

One of the most remarkable records made by any Utah crop has been made quite recently by the Spanish onion, a product of such excellent quality that a new Government standard had to be set for it. The crop is grown for the most part on small farms of high-priced land, and where soil and relief are favorable. The field should be level and the soil fertile and rich in humus. Such areas are found in Utah only near the lakes, where the fine sandy loams, silt loams, loams, and silty clay loams give good yields. The strip from Farmington to Woods Cross in Davis County meets all these requirements and is accordingly the center of onion production, having shipped nearly 100 carloads to

Eastern markets in 1922. Onions are not excluded from the rest of the Oasis, however; a few farmers near Ogden, Willard, and Provo grow the crop on a commercial scale.

Spanish onions are becoming increasingly important because of their value as a cash crop and because of their almost certain yield. The large distant market insures a good price and bumper yields are generally secured—375 bushels per acre on 400 acres in 1923. Individual yields often run up to 800 bushels per acre.

Potatoes

Slightly more than one-half (972,530 bushels) of the potatoes of Utah were produced on 6724 acres in the Oasis in 1919. Potatoes find almost ideal soils in this region. They are grown on nearly every type of the lacustrine deposits, both on the plain and on the bench lands, but they find in the sandy loams, loams, and silt loams admirable conditions for their production. When grown on clays and clay loams, the tubers become knotty, deformed, and consequently valueless owing to the poor drainage. With moderate care yields of 250 to 350 bushels are not uncommon on the better soils. The average yield for the Oasis in 1919 was 145.2 bushels. During that year Davis led the other Oasis counties with an average of 161.9 bushels per acre.

The potato crop of Utah is limited not by natural environment, but by irregularity of markets. During the past few years most of the crop has been grown for local consumption. However, certain fancy varieties, especially those suited to baking, move to the East; hundreds of carloads, 1823 in 1922, are shipped to Chicago annually. But the growing of potatoes for sale in distant markets is precarious, for about the only years of assured high returns for the Utah farmer are those of poor yields in the East. As was shown in the discussion of sugar beets, potatoes cannot well stand the costs of transportation to distant markets. Approximately $100.00 is required to ship the yield of an acre of potatoes from the Oasis to Chicago, whereas $17.50 moves the sugar produced from an acre of sugar beets to the same destination. This difference shows that Oasis farmers can best compete in distant markets by growing products that

can be converted into concentrated form. As a result, the potato crop is being neglected in many places in the Oasis.

However, potatoes will probably continue to be raised by the majority of the farmers, because they furnish a cheap food, they cannot be shipped in from adjoining states at a profit, they are adapted to Oasis soil and climatic conditions, and they fit into the general scheme of rotation. Few inter-tilled crops demand so little man labor as potatoes. Moreover, they do not conflict with other important field crops in their requirements for labor.

Nearly all the potatoes in Utah are irrigated. In some of the lower areas, however, especially in the vicinity of Utah Lake and south of Salt Lake City, where the water table is relatively near the surface, from two to three feet, potatoes thrive without irrigation.

This crop is an excellent inter-tilled crop in the valleys because it has greater resistance to cold than tomatoes and corn, and is fully as resistant as peas. During the nights when cold air gathers in the valley bottoms, corn and tomatoes are constantly in danger, but potatoes are not. Potatoes are usually planted about March 1st and are dug and hauled between September 1st and November 1st.

V. Pastures

In Utah the term "pasture" refers to the grass of low moist land or to that which is irrigated, and not to the natural vegetation of the open range. In this thesis, however, the term will include "all herbaceous feed gathered directly by domestic animals."

Oasis pastures in pioneer days

A clear conception of early Utah pastures is given in the Census of 1880:

> It would be difficult for a person who had never seen a locality of abundant bunch grass but sparsely grazed, to credit the stories of the pioneer Mormons regarding the profuseness and strength of the varieties which in early days they declare covered to a height of from 14 to 20 inches every valley and mountain slope favorable for their growth.

Work-cattle, worn out by labors of the overland journey and turned loose to pass the winter as best they might, astonished their owners by improving in flesh, being in the spring "beef fat." No range of any extent could be found in Utah today west of the Green and Colorado Rivers where animals could find bunch grass plentiful enough to keep them in good order through the winter and spring months.[63]

So extensive was the grazing land on the public domain and so small and intensively tilled were the individual holdings, that no parts of the farms were reserved for pasture. Certain portions of the valley lowlands, however, were set aside (subject to approval by county court after 1852) as common herd grounds for each community. To these pastures the milch cows, dry stock, heifers, and idle oxen of the whole settlement were driven by a town herdsman each summer day and returned to their owners at night. Since the work animals could not be stall-fed because of insufficient hay, they were taken to the herd-grounds at night and guarded by armed sentinels in order to prevent theft by the ever-threatening Indians who were often successful in stealing whole herds of cattle and horses.

The development of farm pastures was neglected under the early Mormon system of communal and coöperative settlement and retarded by the introduction from California in the 50's of the easily and cheaply grown "lucern." Consequent upon increase in population and the influence of Gentile settlers in the rural communities, the common herd-grounds have nearly disappeared and alfalfa production has become more costly. The best summer grazing grounds, heretofore a part of the public domain and available to all who would use them, are now included within the national forests, and are unavailable to the farmers except the few who are able to obtain government permits. These new conditions have thus recently necessitated the development of farm pastures for summer grazing of much stock.

FACTORS INFLUENCING THE USE OF LAND FOR PASTURE

In general, climate and relief are the most significant physical factors determining the suitability of lands for crops or pastures

[63] *Tenth Census of the United States, Vol. III, Agriculture* (Washington, 1880). p. 119.

in Utah. On the deserts and mountains, rainfall and temperature determine the type of vegetation and the extent and distribution of the pasture lands, while the high relief of the mountains prohibits their utilization for all types of agriculture except stock rearing wherever the grass and shrub cover are adequate.

Drainage and soil, however, become the determining factors in the Oasis, though climate and relief still exert a significant modifying influence. The low, water-logged areas along the base of some of the benches and adjacent to the lakes are valueless except for pasture. Under present economic conditions the expensive drainage necessary to make them tillable and productive is not justified except in exceptionally favorable instances.

DISTRIBUTION OF PASTURES

The economic inter-relationship of Oasis, desert, and mountain pastures, necessitates a consideration of each type. These pastures are utilized at different times of the year by the same animals. They are classified as permanent, rotation, and temporary.[64] Those on the desert and national forests are permanent, as are many within the Oasis. Rotation pastures, less numerous, than the permanent, are confined principally to the larger holdings of the more progressive farmers who graze their alfalfa fields for a year or two before planting with potatoes, corn, or wheat. Important temporary pastures of the stubble type are utilized in the fall on the dry-farmed benches and in the valley wheat and beet fields; while those of the aftermath type are common on the general farms in the fall after the alfalfa and wild hay have been harvested.

The pasture lands in farms of the Oasis proper, according to the 1910 Census, probably did not exceed 99,058 acres, 25 per cent of the total pasture lands (395,147 acres) of the five Oasis counties; but they probably constituted the entire extent of improved pasture.[65] The aggregate pasture lands within the Oasis counties

[64] "Kinds of Pasture" *Yearbook of the Department of Agriculture* (Washington, 1923), pp. 372–377.

[65] Improved pasture includes that which has been cleared or tilled.

(395,147 acres) constituted 39 per cent of the total farm land (1,022,780 acres) which in turn was only 18 per cent of the total area (5,792,000 acres). The distribution of pasture land in these several counties appears in table 12.

OASIS PASTURES[66]

Farm pastures are concentrated almost wholly on the benches and water-logged sections of the plain. Economic stress necessarily restricts them on the small costly valley farms which demand intensive tillage. Many of the larger farms consist of an upland stretch of spring pasture; a strip of dry-farm land

TABLE 12

Pasture land on farms in the Oasis counties (1910 census)

COUNTY	TOTAL LAND IN FARMS	LAND IN CROPS	PASTURE LAND				ALL OTHER FARM LAND	PERCENTAGE OF TOTAL FARM LAND DEVOTED TO		ACRES IN PASTURE PER 100 ACRES IN CROPS
			Total	Improved	Woodland	Other		Crops	Pasture	
Boxelder	343,185	89,989	142,990	13,833	5,037	124,120	110,206	26.2	41.7	158.9
Davis	127,257	37,499	37,210	1,355	2,174	33,681	52,548	29.5	29.2	99.2
Salt Lake	169,262	50,531	71,600	55,364	2,655	13,581	47,131	29.8	42.3	141.7
Utah	234,717	81,357	63,510	11,498	5,231	46,781	89,850	34.7	27.1	78.1
Weber	148,359	39,741	79,837	17,008	25,254	37,575	28,781	26.8	53.8	200.9

immediately below; an irrigated plot in hay, silo crops, sugar beets, or vegetables still lower; and at the bottom a meadow pastured in summer after the spring range is dry. The dry-lands are being increasingly sown with oats, sudan grass, or other hay crops that make rapid spring growth. By this practice of raising required forage, land under irrigation is released for the production of sugar beets and vegetables, and makes possible maintenance of a dairy herd or the feeding of stock that graze in the forests in summer.

[66] For the relation of Oasis pastures to the livestock industry, see pages 241–242.

Most of the dairy farms consist of a few acres of intensively-tilled, high priced crop land adjoined to about 60 acres of cheap, water-logged pasture land. Thousands of acres of wet land occur in the valley bottoms near Payson, Spanish Fork, Provo, Linden, Lehi, South Salt Lake, Centerville, Farmington, Willard, and Brigham City. All of these sections, except Payson and South Salt Lake, are contiguous to the shores of Utah and Great Salt Lakes. The largest and most desirable tracts lie along the eastern sides of Utah Lake and Bear River Bay, the northeastern arm of Great Salt Lake, because they are fresh water bodies. In the latter area, about 11 miles southwest of Brigham City (the site of the North Bay Drainage and Irrigation Project) 20,000 acres of prospective farm land are now devoted to pasture.

A farm average of 31 acres of pasturage was determined by a farm-management survey party that studied the Valley of the Great Salt Lake in 1914.

Grasses suited to Oasis conditions

An estimate made from pasture schedules of the Bureau of Markets and Crop Estimates, United States Department of Agriculture, for the year 1922, would indicate that approximately 80 per cent of the pastures are composed of wild grasses and 20 per cent of tame grasses. The latter include Kentucky blue-grass, red top, Rhode Island bent, timothy, orchard grass, red clover, alsike clover, white clover and sweet clover; the former are slough grass, tussock grass, and salt grass.

Kentucky blue-grass, *Poa pratensis*, is a valuable component of many Oasis pastures. It spreads rapidly without seeding, and in fertile soil tends to crowd out other plants by its dense early spring growth. Because it develops slowly from seeding and because it requires a cover growth while young, it is rarely sown alone.

Timothy, *Phleum pratense*, a precocious grass that produces forage quickly after sowing, is one of the important tame pasture grasses in the region. It requires a moderately moist fertile soil. In permanent pastures, timothy is usually displaced by the more persistent grasses, but yields much forage while they

are becoming established. It is one of the best rotation grasses for temporary pastures.

Rhode Island bent, *Agrostis canina,* well suited to wet conditions, is an important pasture grass in the low poorly drained lands. It flourishes when grown in a mixture with other grasses.

Red top, *Agrostis alba,* intimately associated with Rhode Island bent, and adapted to similar conditions of soil and climate, is grown in the same sections.

Orchard grass, *Dactylis glomerata,* is grown on the deep rich soils, though it can be produced on poor soils. This plant does well when mixed with other grasses and in this region is often sown with alfalfa.

Red clover, *Trifolium pratense,* is grown only on fertile, well-drained soil. It is often planted with timothy or Kentucky blue-grass.

White clover, *Trifolium repens,* is an excellent complement for Kentucky blue-grass and is frequently found in the better pastures. It grows close to the ground and spreads rapidly because its stems take root from node to node.

Pasture mixtures

A mixture of pasture grasses is advantageous in the Oasis for several reasons. No one species grows successfully on all the varied soils of the area, and yet each may be well adapted to some one soil type. Sown in combination they may also the more effectively utilize all the soil, by drawing upon the different root zones. Likewise no one species grows successfully in all seasons, and yet each may be well adapted to some one kind of season. A mixture is therefore more likely to yield uniform production throughout a series of seasons. Similarly since not all species reach their full development at the same time, a combination tends to insure a succession of maturing forage and to prolong the pasture period. Thus a well-chosen mixture is likely to yield good pasturage upon most kinds of soil throughout the season.

The following mixtures of grasses for pastures under irrigation have given favorable results at the Utah Agricultural College:[67]

	pounds
1. For bench-lands under irrigation:	
Kentucky blue-grass	12
Bromus inermus	8
Perennial rye-grass	6
Orchard grass	3
White clover	2
Red clover	2
Alfalfa	2
2. For light sandy soils under irrigation:	
Kentucky blue-grass	8
Fescue	12
Meadow oatgrass	5
Bromus inermus	8
White clover	2
3. For low moist lands:	
Perennial rye-grass	8
Red top	10
Rhode Island bent	4
Meadow fescue	4
Timothy	2
Alsike clover	5
White clover	2

Care of Oasis pastures

As a rule pastures are not well cared for in this region. Locally they are grazed only by cattle and horses, animals which select the most desirable plants and keep them cropped; and as a result the less valuable kinds grow, produce seed, and develop a weed pasture that must be mowed before the noxious weeds mature if good forage is to be preserved; or sheep and goats may be kept to destroy the weeds by their close grazing.

Other pastures are grazed too closely and the stand of grass injured thereby; all progressive farmers guard against this danger by dividing their pastures into plots of which some are renewing the grass stand while others are being grazed. Mr. W. A. Nuttall, owner of Utah's champion Jersey herd admirably exemplifies this successful practice on his farm in the Provo area. He sup-

[67] Harris, F. S., "Pastures and Pasture Grasses for Utah," *Circular No. 15, Utah Agricultural College Experiment Station* (Logan, Utah, 1913), pp. 39–40.

ports 25 head of cattle with both hay and pasturage on 18½ acres. He has divided his farm into three equal sections. On section number one, which comprises Kentucky blue-grass and white clover, the hay is never cut. On this he pastures his herd for one month in the spring while the alfalfa is growing in the other two plots. The alfalfa is then cut for hay on field number two and the stock are afterward turned into pasture for one week. During this time the hay in section number three is being harvested. The cattle are then pastured on this plot the next week. Meanwhile, the grass in section one has grown sufficiently to care for the herd for another month, while the alfalfa in plots number two and three is growing another hay crop. During 1922, this dairyman had adequate pasture for his cows from April 15th to December 1st, and raised enough hay for all his winter stall-feeding.

TABLE 13

*Carrying capacities of principal forage types of Utah national forests**

TYPE	ELEVATION	ACRES PER COW	ACRES PER SHEEP
Sagebrush	4,650- 6,500	24	4.5
Browse	6,500- 7,800	13	3
Aspen	7,500- 8,500	12	3
Coniferous timber	9,000-11,000	32	6

* Data furnished by Ernest Winkler, U. S. Forest Service, Ogden, Utah.

FOREST PASTURES[68]

In the mountains adjoining the Oasis, where there is adequate moisture for the growing of forests, many open places covered with grasses and herbaceous plants furnish good summer forage for about 108,500 cattle and horses and 462,500 sheep. These pastures with their approximate elevations and carrying capacities are listed in table 13. Practically all this land lies within the limits of the national forests.

Prior to their inclusion within the reserves, these lands were a part of the public domain, and their forage conditions were deplorably bad. Vagrant stockmen roved about the country

[68] For the relation of forest pastures to range livestock see pages 235–238; 246–251.

pasturing their flocks first on one range and then on another. Their sheep often denuded a whole range in a single passage. To protect themselves the resident stockmen grazed their animals more heavily and earlier each season than before. With the arrival of spring each grazier would drive his animals at once to the earliest green pasturage, then to the next and the next, striving always to keep ahead of competing stockmen. This practice of early grazing became particularly destructive when

FIG. 17. OVERGRAZED AREA ON THE WASATCH NATIONAL FOREST (UNITED STATES FOREST SERVICE)

the animals closely followed the retreating snow-line, cropping the earliest vegetative growth almost as soon as it appeared. The stock of succeeding herdsmen cropped the successive growths as soon as they developed, and the pasturage had no time to gain strength or to seed between successive croppings. Consequently many ranges were practically annihilated. The plants were weakened, no seed developed, and reproduction ceased. Either inferior forage plants, brush, or weeds replaced them, or no growth at all succeeded. This condition was in-

tensified near streams and water holes, and on permanent bedding and salt grounds (figs. 17 and 18). The situation on many Utah ranges as early as 1880, only 33 years after initial settlement in the Valley of the Great Salt Lake is well indicated in the following statement from the Census of 1880:

> The once best grassed and most valuable pasture grounds of the territory present now scarcely a trace of their former abundant forage grasses or browse feed, and nothing but a constant change of locality makes them serviceable even to sheep. . . . .

FIG. 18. CATTLE CONGREGATED ON AN OVERGRAZED SALT GROUND, UINTA NATIONAL FOREST (UNITED STATES FOREST SERVICE)

In 1880 there was not a single locality west of the Wasatch Mountains from Cache Valley to the basin of the Rio Virgin which did not exhibit effects of overgrazing.[69]

After the inclusion of these lands within the national forests and the adoption of a definite forest policy, the situation improved quickly. The lands were so administered that the officials had "nearly complete charge as to kind and number of

[69] United States Census, *Op. cit.*, p. 119.

animals permitted to graze on a given forest, the time at which they are turned on, the time removed, their distribution, whether grazed alone or with other kinds of animals, and to whom should be given the privilege of grazing animals on the forest."[70]

The work of the forest service has continued to be successful and beneficial. In 1903 the Public Lands Commission received 1400 replies to a questionnaire sent to Western stockmen. The

FIG. 19. DESERT RANGE; SAGEBRUSH. SALT LAKE BASIN (H. L. SHANTZ)

most significant and emphatic of all answers was that to the question, "Do you favor Government control of the ranges under reasonable regulations?" In all, 1091 answered "Yes" and 183 answered "No"; 127 did not state their opinion. This general approval demonstrates that the majority of stockmen have been won over to Government regulation and that they are agreed that the forest pastures can be most effectively utilized for grazing purposes only under such a system as the Government now prescribes.

[70] Stewart, John, "This Public Domain, etc.," *Op. cit.*, p. 37.

DESERT PASTURES[71]

To many the term "desert" is synonymous with "wasteland" (ground valueless for all kinds of agricultural pursuits). In Utah, however, practically all this so-called desert country, except the bare alkali flats, produces plants of some forage value. Much of this vegetation, to be sure, is thorny, coarse, and nearly leafless, but even the driest and most forbidding tracts make

FIG. 20. DESERT RANGE; SALT GRASS, TUSSOCK GRASS, AND RABBIT BRUSH. SALT LAKE BASIN (H. L. SHANTZ)

satisfactory winter range (figs. 19 and 20). The absence of grazing animals in summer on these lands is not indicative of poor feed but of lack of water. During winter the snow supplies the necessary water. Though much of this land is ill adapted to cattle, it may be well utilized by a proper combination of sheep and goats.

[71] For the relation of desert pastures to range livestock see pages 243; 246-248.

Relation of vegetation types to grazing

The whole desert basin floor to the west of the Oasis is covered with vegetation consisting largely of shrubs and weedy annuals. Of these the winter-fat, bud-sage, and galleta grass probably yield the best forage, though greasewood and shadscale contribute no inconsiderable part.

Winter-fat, *Eurotia lanata*, white, hairy, and shallow-rooted, ranging in height from 3 to 12 inches, occupies approximately 10 per cent of the desert pasture. It is exceptionally palatable and nutritious to sheep and supplies considerable forage on the winter ranges.

Bud-sage, *Artemisia spinescens*, occupies rather limited areas in the shadscale regions. It is valued by sheepmen who feed it to their flocks in the spring during the migration towards the mountains. Its tender young shoots enable the animals which have been feeding on winter-fat and shadscale to thrive. It is especially valuable during lambing season.

Shadscale, *Atriplex confertifolia*, lying below the sage-brush and just above the salt desert shrub, comprises about 50 per cent of the desert pasture. It is foraged primarily by sheep.

Galleta grass, *Hilaria jamesii*, occurs over large areas and constitutes one of the best grazing types of the region. It is relished by all classes of stock and can stand relatively heavy grazing.

Greasewood, *Sarcobatus vermiculatus*, ranges in height from 1 to 5 feet and has fleshy leaves and spiny woody stems. The bright green leaves, which have a salty taste, are readily grazed by sheep and cattle.

These dry pastures furnish sustenance to thousands of head of stock, especially sheep, from November to May, and occasionally even to June. On such lands 30 to 60 acres are required to support an animal unit for the grazing season of two to five months (table 14). As the snow melts on the desert the water supply disappears, and the animals follow the retreating snow-line up into the mountains. May and June find them grazing the foothills pending their admittance to the national forests

on July first, and late September finds them cropping the sweet alpine grasses in the shadows of the highest peaks, almost 12,000 feet above the sea and 7600 feet above their spring pastures on the desert flats.

TABLE 14

Length of grazing season and carrying capacities of desert forage types

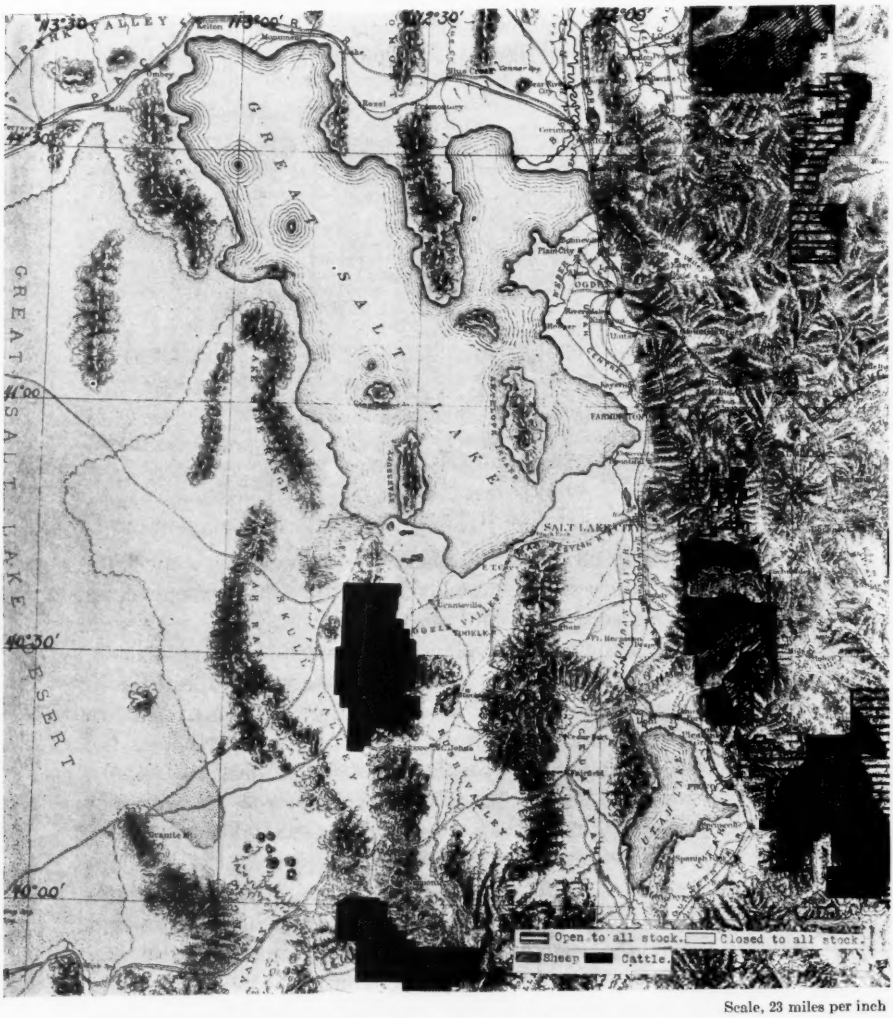
FORAGE TYPE	LENGTH OF GRAZING SEASON	CARRYING CAPACITY (ANIMAL UNITS PER SECTION)*
	months	
Winter-fat	2-5	7-14
Bud-sage	2-5	7-14
Shadscale	2-5	4-14
Galleta grass	2-5	4-14
Greasewood	2-5	4- 7

* The animal unit is a measure of livestock consumption of feed. It is the amount of forage required to maintain for a period of one year, 1 cow, steer, horse, or mule, 5 hogs, 7 sheep or goats, or 100 poultry.

VI. Forests

Heavy coniferous forests mantle the mountains, especially the Wasatch, whereas trees are lacking in the Oasis except along the streams where willows and cottonwoods hug the banks, and in the cities and towns where planted box elders, poplars, locusts, and black walnuts line the streets. Obviously this difference in natural vegetation is due to the sharp differentiation of the two regions in relief, soil, and climate. The forested portion of the mountains is bounded by irregular lines due to local conditions. Above it occurs alpine pastures, while below on the broken foot hills occur dwarfed, ragged groves of piñon pine and cedar.

The mountain forests are of vital significance in the development and welfare of the Oasis and therefore warrant consideration. They store in their fastnesses the heavy winter snows that supply the region with water for irrigation and domestic use, they comprise the summer grazing grounds for hundreds of thousands of sheep and cattle, and they provide a relatively important timber supply. The better forested lands are included within the national forests, which were established to maintain



Scale, 23 miles per inch

FIG. 21. NATIONAL FORESTS ADJOINING THE SALT LAKE OASIS

a supply of timber and to protect the forest cover which regulates the water supply of the streams.

TABLE 15

*Total area and area in timber in the national forests by Oasis counties**

COUNTY	NATIONAL FOREST	TOTAL AREA	AREA IN TIMBER
			acres
Box Elder	Cache	5,616	3,296
Box Elder	Minidoka	69,252	22,430
Davis	Wasatch	140	80
Salt Lake	Wasatch	99,394	34,714
Weber	Cache	5,472	2,150
Utah	Wasatch	72,384	40,546
Utah	Uinta	246,687	120,000

* Data furnished by T. L. Baker, U. S. Forest Service.

TABLE 16

The vegetation associations and their reaction to elevation and precipitation

ASSOCIATION	ELEVATION	PRECIPITATION
		inches
Salt Flat*	4,210– 4,220	
Grass Flat*	4,220– 4,320	
Greasewood-Shadscale*	4,220– 4,420	
Shadscale*	4,250– 5,000	
Sagebrush-rabbit bush†	4,650– 6,500	11.15
Oak-brush†	6,500– 7,800	13.25
Aspen-fir†	7,500– 8,500	27.18
Spruce-fir†	9,000–11,000	25.40

* These associations are dependent to quite an extent on local conditions and do not correlate definitely with climatic conditions.

† Sampson, A. W., "Climate and Plant Growth in Certain Vegetation Associations," *Bulletin 700, United States Department of Agriculture* (Washington, 1918), p. 31.

DISTRIBUTION

Parts of the Minidoka, Cache, Wasatch, and Uinta National Forests lie adjacent to the Oasis (fig. 21). Most of the forested lands occur in the higher mountains adjoining the southern half of the region where the precipitation is heavier. The situation in each Oasis county is shown in table 15.

Physical Factors Influencing Forest Growth

Rainfall is the most significant physical factor influencing forest growth. This fact is well illustrated by the transition in the natural vegetation in the ascent from the shore of Great Salt Lake to timber line (11,500 feet) on the Wasatch, the slope representing a difference in elevation of 7290 feet. The associations given in table 16 occur at the several altitudes of 4210 to 11,500 feet.

Sampson in summing up his climatic comparisons says:

> The mean annual temperature is highest in the least elevated type zone and decreases gradually with the increase in altitude until, in the spruce-fir association, the season of growth covers a period of only 70 days. In the oak-brush type zone the growing season is approximately 120 days. Precipitation on the other hand, is normally only about half as heavy in the oak-brush types as in the type zones above. In general, however, the precipitation is somewhat heavier in the aspen-fir than in the spruce-fir type zone. The precipitation is rather uniformly distributed throughout the year. The evaporation is highest in the oak-brush type, where the greatest heat units and least rainfall are recorded. The evaporation factor is nearly as intensive in the spruce-fir type, however, while in the aspen-fir association it is only half as great. The strong evaporation in the spruce-fir type is accounted for by the high wind velocity, which often exceeds 40 miles per hour for several hours in succession. The seasonal wind movement in the spruce-fir type is approximately 100 per cent greater than in the association below. The possible and actual sunshine are found to be practically identical in the respective types.[72]

SPECIES OF TREES AND THEIR RELATION TO THE TIMBER SUPPLY

Compared with many stands of virgin timber in eastern and northwestern United States, the forests under discussion are markedly inferior both as regards species of trees and quality of wood. The species are restricted because of adverse physical conditions, "aridity on the one hand and intense cold on the other, factors which successfully repel deciduous trees."

[72] Sampson, A. W., *Ibid.*, p. 36.

Nearly all the trees used for timber belong to the pine, fir, or juniper families.

Douglas fir, *Pseudeotusga taxifolia*, grows at elevations of 6000 to 9000 feet and is the most important timber tree of the Wasatch Mountains.

White fir, *Abies concolor*, occupies heights from 6000 to 8000 feet and forms an important part of the forest cover of the Wasatch Range as far north as Logan Canyon.

Alpine fir, *Abies lasiocarpa*, growing between 7000 feet and timber-line is of slight commercial value at present, because the wood is of poor quality and the stands are relatively inaccessible.

Another variety of fir, *Abies menziesii*, locally called "spruce" is botanically similar to *Picea Engelmanni*, but is found mostly along canyons between 7000 to 9000 feet, terminating where the other begins. This tree would rival the Engelmann spruce were it not for the fact that its trunk contains numerous slight curves which render it unfit for saw logs.

Lodgepole pine, *Pinus contorta*, limited to the northern portion of the Wasatch Mountains at elevations of 8000 to 10,000 feet, is not found south of the head of Blacksmith Fork; it extends south through the Uintas, however, to the headwaters of the Provo River.

Western yellow pine, *Pinus ponderosa*, grows at altitudes of 8000 to 9000 feet, attains a large size, and is used to some extent for mine props and for ruder building purposes.[73]

Piñon pine, *Pinus edulis*, which covers the lower slopes adjacent to the river valleys, is diffusely branched and scrubby and therefore valueless for timber except as mine props and fire wood.

Engelmann spruce, *Picea Engelmanni*, grows on the high, cool, moist slopes from 8500 feet to timber-line. Beyond this elevation, the tree becomes dwarfed. It appears to flourish at an altitude of about 10,000 feet, where it becomes a large beautiful tree (fig. 22). The trunks are straight and free from limbs and knots, making excellent saw logs. The wood is white and soft, but fine-grained and durable.

[73] Powell, John, *Op. cit.*, p. 100.

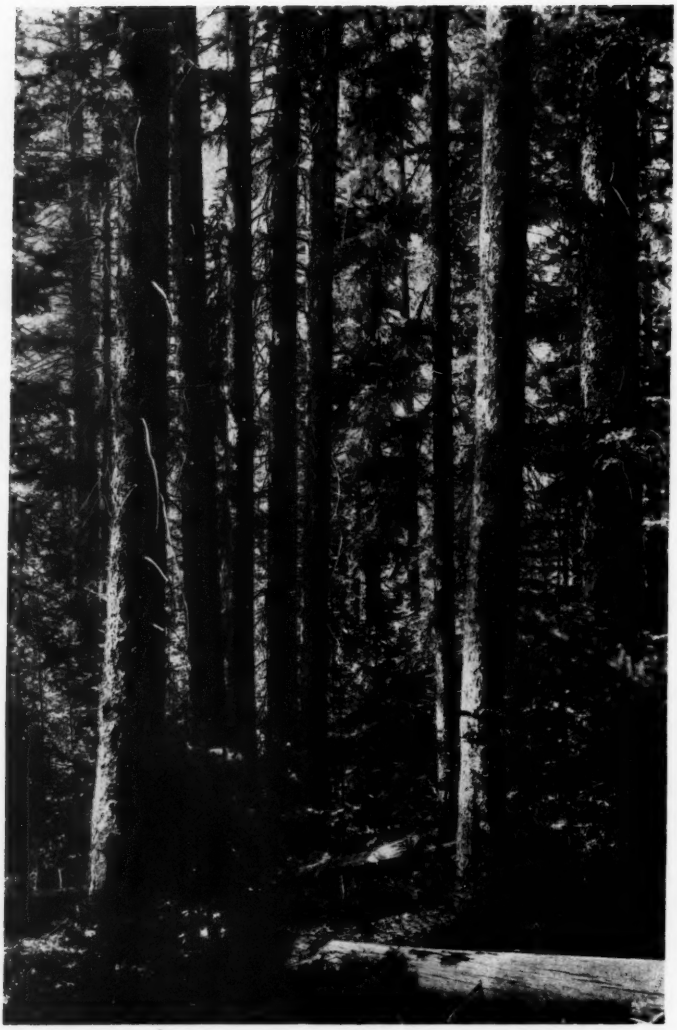


FIG. 22. AN ENGELMANN SPRUCE FOREST ON THE HEADWATERS OF THE PROVO RIVER

Blue spruce, *Picea parryana*, is not sufficiently common to be of commercial value, nor is its wood as good as that of the Engelmann spruce. This tree, occupying heights varying from 6000 to 9000 feet, follows the water courses in the front range of the Wasatch south of Big Cottonwood Canyon.

Aspen, *Populus tremuloides*, occupies the moist mountain sides at heights of 7000 to 10,000 feet and is the only broad leaf tree of importance in the Wasatch Mountains. It makes good fence posts.

Rocky Mountain red cedar, *Juniperus scopulorum*, scattered through the mountains at elevations of 5500 to 8000 feet, serves only for posts.

Utah juniper, *Junipera utahensis*, grows in the foothills at heights of 4500 to 6000 feet on hot, dry, southern slopes. It has the characteristic durability of the junipers and consequently makes excellent fence posts. It grows low, is diffusely branched, and is useless for milling purposes.

Cottonwood, *Populus angustifolia*, forms no part of the forest proper, but fringes the lower reaches of streams, rarely appearing at elevations exceeding 6000 feet.

Box elder, *Acer negundo*, and hackberry, *Celtis occidentalis*,[74] thrive along the streams just before they emerge from the mountains.

RELATION OF FORESTS TO GRAZING AND PROTECTION OF WATERSHEDS[75]

Scattered throughout these forests are numerous parks or open spaces, covered with grasses and other herbaceous plants that furnish excellent summer grazing for the bulk of Utah's livestock. They occurred also prior to the creation of the forest service, but in a form that threatened not only the destruction of the forests and ranges, but of the watersheds as well. The ranges in the early days were crowded with flocks and herds;

[74] Powell, John, *Ibid.*, p. 103.

[75] For a more detailed discussion of the relation of the forests to the livestock industry, see pages 223–226; 246–251.

the best lands belonged to the most powerful men. The animals killed out the forage with the result that each successive year witnessed keener competition for the meagre growth, until some areas became mere dust beds. The forest service changed these conditions when the lands became included within the national forests. This organization reduced the number of animals allowed on the ranges, so as to safeguard the forage and watersheds. Even now, however, after years of scientific management, there are literally hundreds of examples of the baneful effects upon stream flow of over-grazing in the mountains bordering the Oasis. Such places, of course, are subject to severe floods after all violent storms, and have a corresponding scarcity of water during periods of drouth. The problem of securing an equable stream flow is a vital one to the towns at the foot of the mountains, which depend on these streams for their water supply on the one hand and suffer occasionally from heavy floods on the other. The absence of floods can be attributed only to protection afforded on the slopes and in the gullies by the plant growth, which delays the run-off until much of the water permeates the soil. Referring to the deleterious effects of over grazing, an editorial in the Salt Lake Tribune under date of August 18, 1923 says,

> A striking case in point is the flood which came out of Dry Canyon, above Federal Heights in Salt Lake City on Pioneer Day in 1916. Immensely large boulders, much heavy debris and earth, and some dead cattle were carried out of the canyon on the crest of the powerful flood.
>
> This flood has been attributed chiefly to the fact that the canyon up to that time had been rather intensively grazed and burned over in a few places. City Creek Canyon, lying next to the north, and which received an equal share of the storm according to the Weather Bureau records, as nearly as could be determined, received but a very slight rise in stream height. This was because City Creek had not been grazed for many years and a fine absorbent and deterrent surface of grass, vines, brush, and general vegetation had been accumulated.
>
> There is little danger of disastrous summer floods due to heavy rains coming out of the canyons around Salt Lake City, because none

of the watersheds are grazed heavily, if at all (fig. 21), and most of them are well covered with vegetation.

Recent disasters occured in Salt Lake Valley at Farmington and Willard on August 13th, 1923. Torrents of muddy water bearing heavy boulders and logs swept from the mountains and deposited thick layers of debris in the houses, on the lawns, and on the crops; carried away barns, submerged automobiles and farm machinery, and uprooted bearing fruit trees. The floods caused heavy depreciation of real estate values, delayed

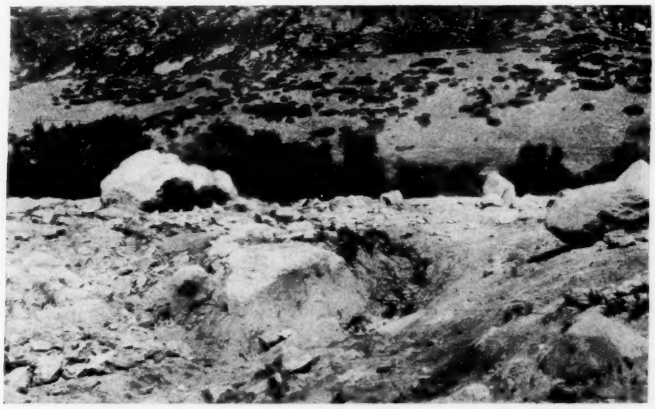


FIG. 23. A FARMINGTON TRUCK GARDEN STREWN WITH BOULDERS AFTER A CLOUDBURST

business, filled and destroyed reservoirs and irrigation ditches, and killed a number of persons. At Farmington about 170 acres of farm land were so heavily strewn with boulders as to be irreclaimable. Much of this was high-priced truck and market-garden land which varied in value from $200 to $500 per acre. The remaining 105 acres were carpeted with mud and debris to a depth of 2 inches to 3 feet. The detritus consisted of gravel, sand, and clay mixed in all sorts of proportions but so lacking in organic matter as to be of low crop producing value (fig. 23). At Willard 20 homes were damaged and about twice as much land

injured as at Farmington. A great tract of boulders, many of which weigh tons, cannot be cleared. There are hundreds of thousands of smaller rocks, the removal of which would cost at least 20 times the agricultural value of the land (fig. 24). This cloudburst, the most intense on record, occurred also at City Creek, but the stream rose less than three-tenths of an inch according to precipitation records. This proves conclusively the value of restricting grazing in the watershed areas.

FIG. 24. A WILLARD PEACH ORCHARD EMBEDDED IN DEBRIS BROUGHT DOWN FROM THE WASATCH DURING A CLOUDBURST

RELATION OF NATIONAL FORESTS TO RECREATION

The recreational use of the national forests is only in its infancy. But within the confines of these reserves are trout streams, scenic wonders, and medicinal springs. Roads and trails have penetrated these highland regions until they are quite accessible. The Utah forests possess different characteristics in different portions. In northern Utah, in the Cache National Forest, the mountains are moderately high, not heavily forested, and afford pretty rather than spectacular scenery. To the south, however, in the Wasatch and Uinta Forests, the main ranges are characterized by many high, rough, and rugged peaks, the

highest in the state. Farther south in the great plateau section, occur meadows and broad coves, divided by long flat-topped open ridges. This general plateau formation extends from the Manti National Forest to the southern border of the state and is gashed by canyons in many places and in others eroded into fantastic forms as at Bryce Canyon and Cedar Breaks.

FOREST NURSERIES

Two of the three large intermontane forest nurseries are located at Beaver Creek and Cottonwood in the Wasatch National Forest just opposite Salt Lake City. They produce annually 1,500,000 seedlings. The stock is used in planting burned and denuded areas within the forests.

COMMERCIAL USE OF THE FORESTS

The native merchantable timber in Utah is Western Yellow pine, Engelmann spruce, Lodgepole pine, Douglas fir, and white fir. The cordwood species are the juniper, aspen, and piñon pine. It is estimated that on the national forests of the state there are between seven and eight billion board feet of merchantable saw timber, railroad ties, and mine props. "In addition there are vast tracts of quaking aspen which will some day supply pulp mills throughout this region."[76] The annual lumber consumption of the region is placed at about 150,000,000 feet, practically all of which is supplied by the large Pacific Coast concerns. The few small mills operated locally supply less than 10 per cent of the demand.

VII. Livestock

The Salt Lake Oasis, by virtue of its excellent geographic location, serves as a livestock collecting and distributing center for much of the intermontane country. Accordingly, a discussion of certain phases of the livestock industry requires an analysis of the dominant geographic conditions not only for the Oasis, but for its entire tributary area.

[76] Kneipps, L. F., "Utah's Forest Resources," *Statistics and Resources of Utah* (Salt Lake City, 1917), pp. 175–176.

Utah is typical of all the intermontane states: all suffer from aridity, all have a rugged relief apart from their arid plains, and all have certainly less than 15 per cent of their area arable. As a result of these conditions most of their territory must be devoted to stock-rearing, the product of which finds its way to the Ogden and Salt Lake markets.

Utah, a portion of this larger area, is destined to remain primarily a stock rearing state because about 95 per cent of its 52,597,760 acres is not susceptible of tillage. The irrigated sections may be increased slightly and the dry-farmed areas extended, but uncultivated land will predominate because of rugged topography and aridity. In addition, stock rearing is favored by the fact that a number of farming communities, far from transportation lines, cannot market ordinary field crops, and must convert them into livestock which can be driven to market.

HISTORICAL DEVELOPMENT OF THE LIVESTOCK INDUSTRY

The livestock industry developed early and rapidly in Utah. Attached to the ox-drawn wagons of the van of the Mormon pioneers were a few milch cows, which had served in the yoke. Additional cattle came with each immigrant train. The livestock wintered in 1847 by the Mormons comprised 3000 cattle, 50 swine, and numerous horses and mules. A few flocks of coarse-wooled Illinois sheep were brought by the companies arriving in 1848. Many cattle, sheep, and swine accompanied each succeeding train. Furthermore, thousands of steers and cows of excellent breed, but poor, exhausted, and footsore, were traded to the Mormons for provisions, mules, and Indian ponies by the gold seekers between 1849 and 1854. Lame stock by the hundred was obtained along the emigrant road all the way from the Sweetwater to the Humboldt; it was then fattened on succulent Utah grasses, and later sent to California in exchange for gold dust.[77] In 1853 a drive of some 2300 work steers was made to the Sacramento market, where the animals sold at

[77] Bancroft, H. H., *Bancroft's Works, History of Utah, Vol. XXVI* (San Francisco, 1889), p. 729.

$200 to $250 per yoke. At intervals thereafter up to 1870, surplus beef cattle and mutton sheep were driven to California and later to Nevada, Idaho, Montana, Wyoming, and Colorado.

The constant infusion of new blood into the stock of the Utah Oasis greatly improved the condition of the herds and flocks, gave an excellent quality of beef and mutton, and stimulated the spread of the livestock industry in the Salt Lake basin. Cattle were driven by the Mormons into almost every valley west of the Wasatch Mountains, where good pasture was available, during the first 10 years of settlement.[78] Sheep were reared by almost every husbandman as a means of supplying wool for clothing.

PRESENT STATUS

The number of livestock reared in the Salt Lake Oasis is not great. In 1919 there were on farms and ranges in the five counties, parts of which comprise the Oasis, 345,822 sheep, 64,589 beef cattle, 44,645 dairy cattle, 39,466 hogs, 41,900 horses, 523 mules, and 456,639 poultry.

The livestock industry presents many interesting and apparently anomalous problems. Some of these are geographic, others economic, and still others social, though most often they are a combination of all. These problems will be analyzed in the ensuing pages.

RELATION OF OASIS FARMING TO LIVESTOCK PRODUCTION

The Salt Lake Oasis bears an intimate relation to the livestock industry of its hinterland, because of its location between the grazing lands of the lofty Wasatch Mountains on the east, and the lower basin ranges and the desert on the west. The Oasis is the magnet to which many of the animals, especially cattle, are drawn for winter feeding, because the mountains cannot be grazed in winter, and the desert pasturage can be utilized only for sheep.

Conditions on most Oasis farms not only favor the keeping

[78] "Utah Territory," *Tenth Census of the United States, Volume 3, Agriculture* (Washington, 1883), p. 117.

of livestock for a part of the year, but go far toward making some form of animal enterprise essential to profitable farm-management. The small size of the farms and the large proportion of town-dwelling farmers, however, tend to decrease considerably the number of head kept in the region.

Several factors encourage the rearing of livestock: first, the preponderance of crops of low value per unit of weight, which to be marketed profitably must be fed to livestock; second, the quarantine against Utah alfalfa, the leading crop in acreage, which prevents this product from being shipped outside the state; third, the large amount of by-products such as beet tops and pulp, and grain straw, which must be utilized for stock-feed or else go to waste; fourth, the presence of numerous patches of water-logged land suitable only for pasture; fifth, the low humidity, pure water, and abundant sunshine, which account for the low percentage of tuberculosis in cattle and hogs; and sixth, the numerous ditch banks covered with rank weeds and sweet clover, which should be kept clean by sheep.

Recent farm-management surveys in both Utah Lake and Salt Lake Valleys, prove conclusively that those farmers who keep livestock are the most prosperous.[79, 80]

RELATION OF NATIONAL FORESTS TO LIVESTOCK PRODUCTION

The close relationship existing between the national forests and the grazing industry cannot be too strongly emphasized. The mountain forest ranges of the state supply summer pasturage of good quality for about 225,000 cattle and horses and more than 1,000,000 sheep, which are owned by more than 9500 Utah farmers, ranchers, and stockmen.[81] On the four national forests which border the Oasis (Cache, Minidoka, Uinta, and Wasatch) there were in 1919 108,500 cattle and horses and 462,500 sheep and goats. These numbers are approximately constant because each forest is grazed to capacity.

[79] Stewart, George, "A Farm-Management Study. . . . ," *Loc. cit.*, pp. 21, 26–28.

[80] Connor, L. G., *Op. cit.*, pp. 29–36.

[81] Kneipp, L. F., "Utah's Forest Resources," *Op. cit.*, p. 183.

The Forest Service efficiently apportions the ranges among the graziers and the different classes of livestock, and supervises the use of the ranges. It aims to operate the forest pastures on a fair and impartial basis, and to furnish forage for the greatest possible number of animals. When the forest service was created, it had to restrict the number of animals on the depleted ranges. This action aroused strong opposition to the organization, because many stockmen considered it an infringement on their personal rights to "free grass." But the regulated use of the forest lands has resulted in a marked improvement in the ranges, especially in those grazed by sheep, because it instituted later entrance dates.

RELATION OF THE DESERT (PUBLIC DOMAIN) TO LIVESTOCK PRODUCTION

The desert west of the Oasis comprises the winter range of a few cattle and thousands of sheep, which come down from the national forests in the fall. Major Powell says of this desert forage,

> Most of the grasses seem to protect themselves from the great aridity by growing in bunches. They appear to produce proportionately a greater amount of seeds than the grasses of the Humid Region, and their nutritive qualities, especially in winter, seem to be due thereto. In general, the grasses seem to have large, strong stems, and are not so easily broken as those of the Humid Region, and the rains and snows by which they would be so broken down are infrequent. Again, for these reasons, the grasses, standing long after they are cut by frosts, cure themselves, forming thereby winter pasturage.[82]

The chief of these is the winter fat, a low nourishing shrub which is eaten close to the ground. The bud sage and the shad-scale have some nutritive value. The desert serves only as a winter pasture, because in the late spring the snow melts and evaporates, thereby removing the sole water supply of the stock.

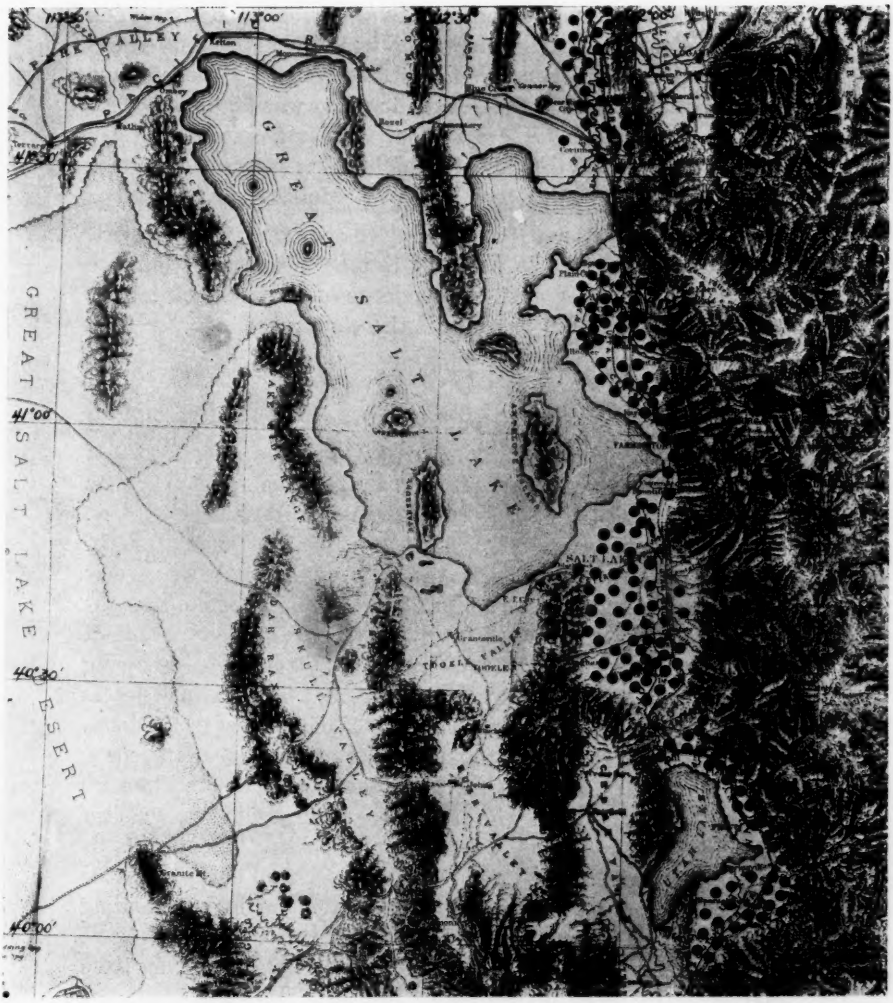
[82] Powell, John, *Op. cit.*, p. 110.

WINTER FEEDING

Thousands of sheep and cattle are fed each winter on Oasis farms in the recently reclaimed sections where grain and alfalfa are the dominant crops. Many of the animals are brought in from the ranges in the early fall to glean the grain and beet fields, and to be pastured for a time on meadows after the last hay crop has been put up. Sheep are winter-fed on Oasis farms chiefly for the economic utilization of surplus bulky crops. For example, in 1921 Utah had a large hay crop locked within its borders by a quarantine on the part of adjoining states against the alfalfa weevil. This condition forced the hay man and the stockman together, and the former marketed his product through the fattened animals of the latter, to their mutual satisfaction. This situation increased lamb and cattle feeding 100 and 15 per cent respectively. "Figures on the number of cattle are not available, but the lambs on Utah feed lots in 1922 numbered 188,000 as against 94,000 in 1921." During the winter 1922–23 this activity became increasingly important; in the vicinity of Riverton alone, 36,000 lambs were fed by 35 stockmen, some of whom had as few as 300 head.

Feeding on a large scale has sprung up recently near sugar factories and mills. The Stockgrowers Mill and Feed Yard Company, which is located in Ogden near the Amalgamated Sugar Factory, fattened for market 109,000 sheep and 1800 cattle in 1922–23. It handled 28,000 lambs for one customer and 19,000 for another. This company makes three kinds of feed: number one contains 10 per cent grain, 20 per cent molasses, and 70 per cent alfalfa meal; number three contains 30, 50, and 20 per cent of the same ingredients, while number five comprises 50, 20, and 30 per cent. Number one is given to animals for two or three days when they enter the yards. Number three is the regular cattle and sheep feed, while number five is suitable for sheep only, it being too strong for cattle. The feeds cost $20, $22.50, and $25 per ton "fed out," which includes loading, unloading, and sorting.

A lamb eats about three and one-half pounds of number five



Scale, 22.5 miles per inch

FIG. 25. DISTRIBUTION OF SHEEP IN 1919
Each dot = 2,000 sheep

per day, while a ewe will consume five pounds. A sheep gains about two and one-half pounds per week for about 40 days, but after that puts on considerably less weight. The average feeding period for the 109,000 sheep handled was 55 days.

RANGE LIVESTOCK

Utah sheep are essentially range animals; they spend the summer in the national forests and the winter in the desert. Utah cattle graze in the national forests in summer, but are fed on farms in winter. The dependence of the livestock farmer on the adjacent natural pastures is therefore great.

Sheep

The rearing of sheep is one of the more important agricultural industries in Utah (fig. 25). In 1919 there was an average of 294 sheep per farm reporting sheep in the five counties, parts of which comprise the Oasis. In the most important county, Davis, the average was 500. Most of these are range animals.

The keeping of sheep on Oasis farms the year round as a regular part of the farm business is limited. A recent farm-management survey in Salt Lake Valley in which 428 farms were studied, reports a very small number of sheep.[83] This is probably owing to (1) the small size of many of the irrigated farms, which necessitates an intensive type of farming, (2) the high cost of the land, which precludes the rearing of livestock other than dairy cows, hogs, and poultry, and (3) the large proportion (more than 90 per cent) of the farmers who live in towns and villages, a factor which necessarily limits livestock production. Since this is the situation within the Oasis, this discussion of sheep must be concerned largely with the industry carried on in surrounding districts as an adjunct to Oasis farming.

The animals enter the national forests in bands varying from 1000 to 1500 ewes with their lambs (fig. 26). When they are dry (without lambs) they are admitted in bands of about 2200. The operation of small flocks, preferably 1200 ewes with their lambs,

[83] Stewart, George, *Op. cit.*, p. 39.

is encouraged by the forest service. The lambs sometimes total as many as the old sheep, though usually the ratio is from 75 to 80 per cent. Many of the sheep which pasture in the forests during summer graze on the desert during winter, though with the increase of winter feeding in the Oasis, many are never taken into the desert. Lambs after five months on the ranges of the Cache, Minidoka, Wasatch, or Uinta National Forests, usually weigh from 56 to 80 pounds. Those reared in the Uinta Forest customarily bring top prices in the Chicago and Pacific Coast markets.[84]

FIG. 26. SHEEP GRAZING IN THE CACHE NATIONAL FOREST (UNITED STATES FOREST SERVICE)

Sheep are herded seasonally to and from the mountains. By this transhumance they are kept in good forage and cool weather both summer and winter. They require from one to three weeks to trail from the mountains to the desert and even more to return, because they occasionally wander as far as 250 miles. Sheep usually remain in the forests from July 1st to September 30th, though when they lamb they are admitted from May 10th to May 21st. They lamb during April and May in the low foothills on private lands, and on carefully selected grounds within

[84] Ernest Winkler, Assistant District Forester, Ogden, Utah.

the national forests. Lambing on farms, however, is more advantageous because fewer lambs are lost.

Sheep are generally grazed at higher elevations than cattle and horses, because they (1) can browse on rougher and rockier land, (2) can endure thirst for a longer period (as much as three weeks), and (3) are dipped prior to entrance into the national forests and hence are bothered to a less degree by the blood-sucking insects, which infest the moist higher elevations.

Sheep are reared in Utah both for wool and for mutton. The Cotswold breed furnishes a long medium wool whereas the Rambouillet and Merino give a short variety. Black-faced Southdowns and Hampshires are bred extensively for mutton, the latter breed being better adapted to winter feeding because of more rapid gains.

Utah sheep yield on an average from six to eight pounds of wool at each shearing. Early in April, if the season is mild, the flocks are headed toward shearing pens, where about 50 head can be sheared by one man each day.

Beef cattle

The beef cattle owned by Oasis farmers in 1919 amounted to 64,589 (fig. 27), making an average of 6.2 animals per farm. The average rose to 14.2 in Box Elder County, an area characterized by large general farms devoted to alfalfa, grain, sugar beets, and potatoes, and by extensive sections of water-logged pasture on the one hand and of arid range on the other. The average dropped to three in Davis County, an area of small expensive farms, devoted largely to market gardening and truck farming.[85]

Hundreds of Oasis farmers rear no beef cattle. An economic survey of the Strawberry Valley Reclamation Project, revealed the fact that 1362 of the 1925 farmers were keeping no range cattle, because they were unable to obtain grazing permits for the national forests, where most of the beef cattle owned by Oasis farmers are grazed (fig. 28). In 1924, two groups of

[85] These figures are based on all the farms in the 5 Oasis counties and not on the farms reporting beef cattle.

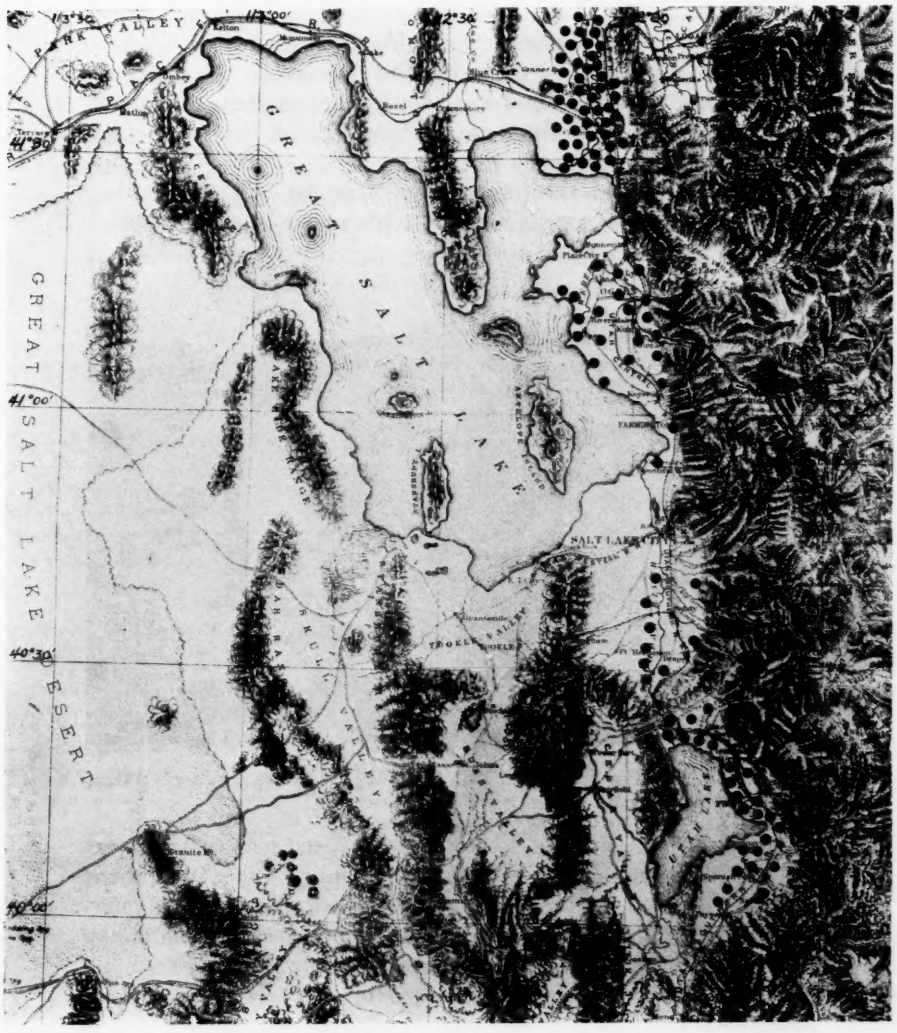


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FIG. 27. DISTRIBUTION OF BEEF CATTLE IN 1919
Each dot = 500 cattle

33,060 and 11,165 head, belonging to 1531 and 533 permittees respectively, were pastured in the Wasatch and Uinta Forests on which most of the Oasis animals are kept. An average, therefore, of about 21 head was held by each grazier, an amount about three and a half times greater than that held by the average Oasis farmer.

Cattle remain in the forests from May 1st to October 31st, a period 92 days longer than is allowed for sheep. A steer

FIG. 28. BEEF CATTLE GRAZING IN THE UINTA NATIONAL FOREST (UNITED STATES FOREST SERVICE)

requires for the grazing season about 17 acres of this pasture, though the amount varies with the type of forage; it is about 12 for aspen, 13 for browse, 24 for sagebrush, and 32 for coniferous forest. This is appreciably less than the necessary quota on the desert where from 30 to 60 acres are required, and far more than on the water-logged Oasis pastures, where 2 to 3 acres suffice.

In contrast to sheep, cattle graze primarily in the intermediate elevations owing chiefly to differences in the character of the

forage, less rugged and exposed surface, absence of blood-sucking insects, and proximity to watering places.

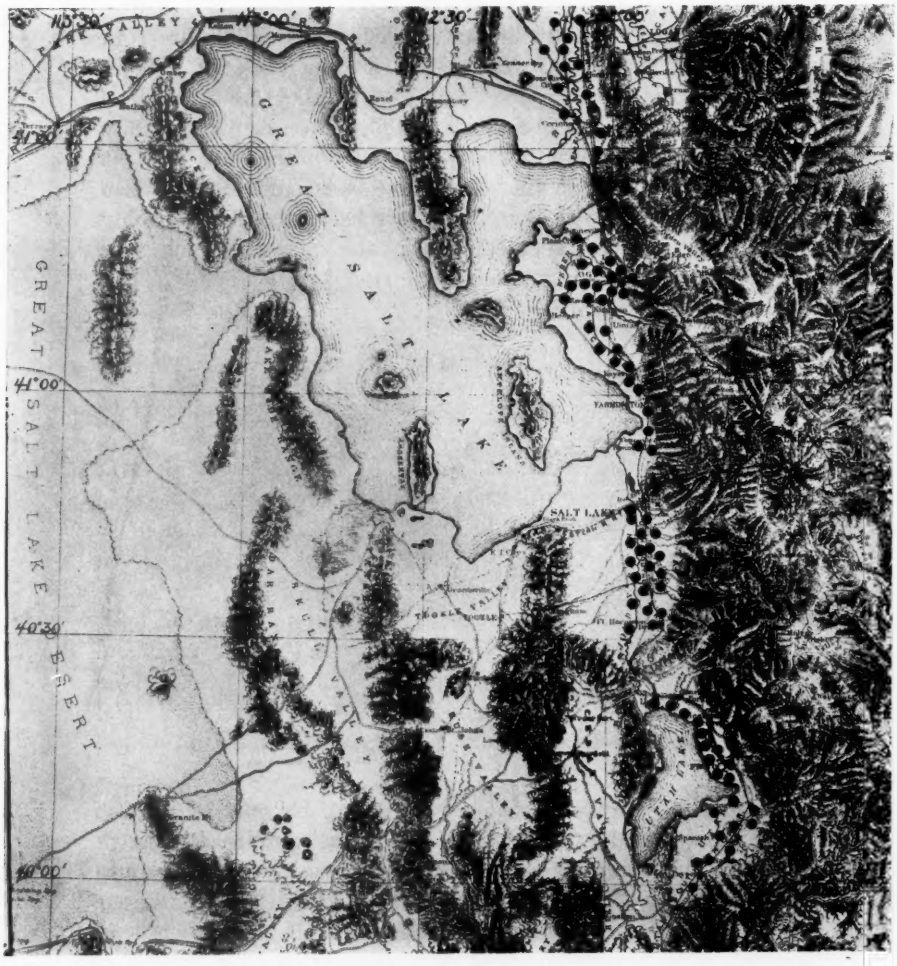
Beef cattle are usually marketed each year. Some are sold directly from the range, while others are pastured for a short period on Oasis farms, and sold as soon as they are classed as prime beef. When these animals are placed on farms, they are given the best pasture. Often they are turned into beet or alfalfa fields, as soon as the crops have been harvested. When this practice is followed, the animals are fed in the fields for only a limited time each day, in order that the quantity which they can consume can be regulated. One steer can graze for about 100 days on an acre of beet tops.

NON-RANGE LIVESTOCK

All the hogs, mules, and poultry, and most of the milch cows and horses are confined to Oasis farms. This is especially true of horses and mules, which are reared almost exclusively for farm use, and therefore are distributed quite evenly over the whole Oasis, with an average of four animals per farm. Occasionally a few idle horses and dry dairy cattle are sent in summer to the national forests, because of scarcity of farm pastures. Also, now and then, beef cattle are kept on Oasis farms throughout the year, though only where the farms adjoin the poorly drained areas near Utah Lake, Bear River Bay, the Bear and Malade Rivers. Therefore, a discussion of Oasis livestock must deal primarily with milch cows, hogs, poultry, and horses and mules.

Dairy-cattle

As population has multiplied in the Oasis, milch cows have become proportionately important, and have increased in number 70 per cent between 1909 and 1919. The dairy industry has shown marked progress. The erection of hundreds of concrete silos, the construction of sanitary barns, the formation of cow-testing organizations for the elimination of inferior milch cows, and the importation of many pure-bred bulls and several carloads of dairy cows during the past few years, are indicative



Scale, 24 miles per inch

FIG. 29. DISTRIBUTION OF MILCH COWS IN 1919
Each dot = 500 milch cows

of the strenuous efforts being made to improve the dairy industry within the region. The results of these efforts are already observable in the marked improvement in the quality of Utah dairy products.

The more important dairy sections of the state, with the exception of Cache Valley, are in the vicinity of the chief urban centers of the Salt Lake Oasis (fig. 29). In the area tributary to Salt Lake City and Ogden, the Holstein breed predominates, whereas the Jersey prevails in Utah Lake Valley, though there also during the past few years the Holstein has assumed some importance. Considerable numbers of Guernseys are interspersed throughout the region, but probably 90 per cent of all the dairy cattle are not registered.

A happy combination for the dairyman is found where the costly irrigated land is farmed in connection with cheaper pasture sections. For this reason the more important dairy farms are located near water-logged areas, as along the eastern shore of Utah Lake, especially near Linden; south of Salt Lake City at various places as far as Draper; on the east shore of Great Salt Lake, especially opposite Bear River Bay; and in the vicinity of Box Elder Lake. The farms near Utah Lake are fairly large, many of them comprising as much as 130 acres, though in 1918 the average of 18 such farms was about 119 acres, one-half of which was in crops. Scarcely any farmer can successfully operate a dairy farm in the Oasis on less than 30 acres, though there are some notable exceptions to this rule.

Dairying is probably the most profitable type of farming in Utah; when combined with beet farming, however, the profit increases 50 per cent.[86] The use of beet tops as fodder, especially the silage, has done much to bring the two branches of farming together. Results obtained from feeding beet silage to cattle, sheep, and hogs in combination with protein feed indicate that a far greater feed value is obtained out of the tops by this method than by using the beet fields as pastures, as has been the custom heretofore. Mr. James G. Waddison of Weber County says:

[86] Stewart, George, *Ibid.*, pp. 35–36.

About the first of January I opened my silo and found the tops had kept perfectly. The cows relished them as much as they did fresh tops, and they did much better when fed only a limited amount than when allowed to run at will on the tops in the field. The milk produced was also of good quality and had no disagreeable flavor that is complained of when cows are fed beet pulp. I have no accurate information as to feed value in pounds, but would say a ton a week fed to six cows would enable them to do nicely on the hay that one cow would eat if fed hay only. I find it also a convenient and valuable feed for pigs. I have decided that beet-top silage shall have a place in my winter feed from now on, even though its care requires a good deal of time in our busiest season, which many farmers complain of.[87]

As a dairy region, the Oasis is unique in at least two respects. In the first place hundreds of farms have not a single milch cow. This may seem anomalous, but when it is recalled that the Oasis is a region of town-dwelling farmers, the reason becomes quite evident. Many of these farmers own from three to six parcels of land at varying distances in the country (fig. 30). Where all these are located close together, the inconvenience of the arrangement is not pronounced. But many have land lying in three or four different directions and none of it as close as two miles from home. "For example, a man will have a field four miles from the town in one direction, another field three miles away in another, and the remainder as far or farther away in a third. The roads may be so planned that the quickest route to any other field from the one in which work is going on is back to town and then out." Under such conditions dairy farming could not be carried on advantageously, and even a single cow would present a problem.

The second respect in which this region is unique is in its "town herds," though these are rapidly disappearing in the Oasis. The presence of numerous poorly-drained areas in the valley bottoms makes available large grazing areas, which have been sown with tame grasses in many localities. As under the

[87] Jones, James W., "Beet-Top Silage and Other By-Products of the Sugar Beet," *Farmers' Bulletin 1095, United States Department of Agriculture* (Washington, 1919), p. 13.

old dairy system of the Mormon communities, the milch cows of the various hamlets are still collected every morning by boy

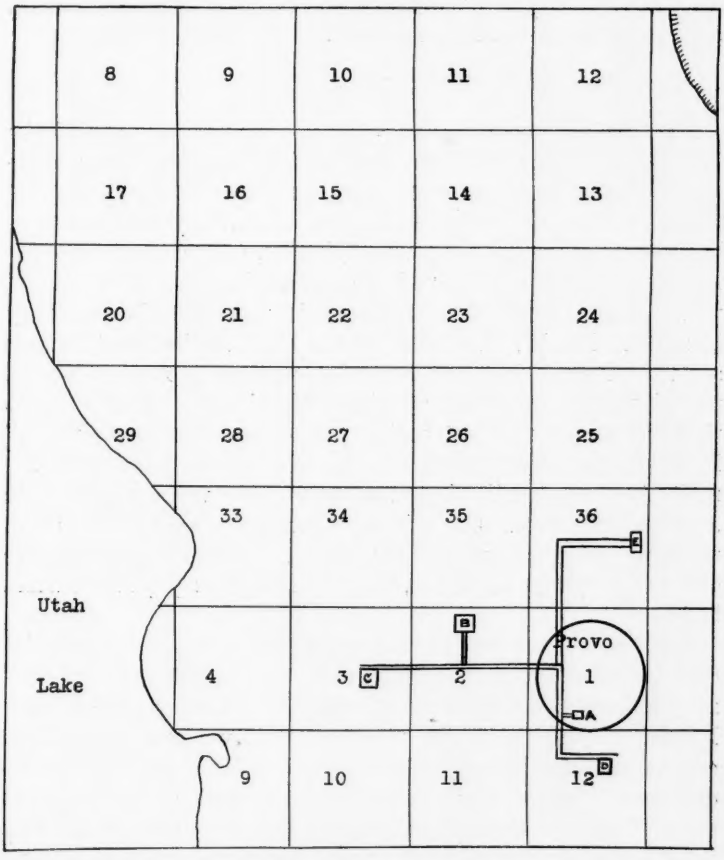


FIG. 30. THE LAND HOLDINGS OF A TYPICAL OASIS FARMER

Plot number D is an inheritance from his father; the others are purchases. This farmer lives in town largely because of the amenities of town life.

herders, taken out from the villages, herded on neighboring grasslands, and led home at night to their owners. The jingle of the cow bells in the early summer morning and evening is a

familiar sound in many a Mormon hamlet. From Provo, for example, which lies adjacent to extensive water-logged areas near Provo Bay, the "town herd" forms an imposing drove, amounting to several hundred head.

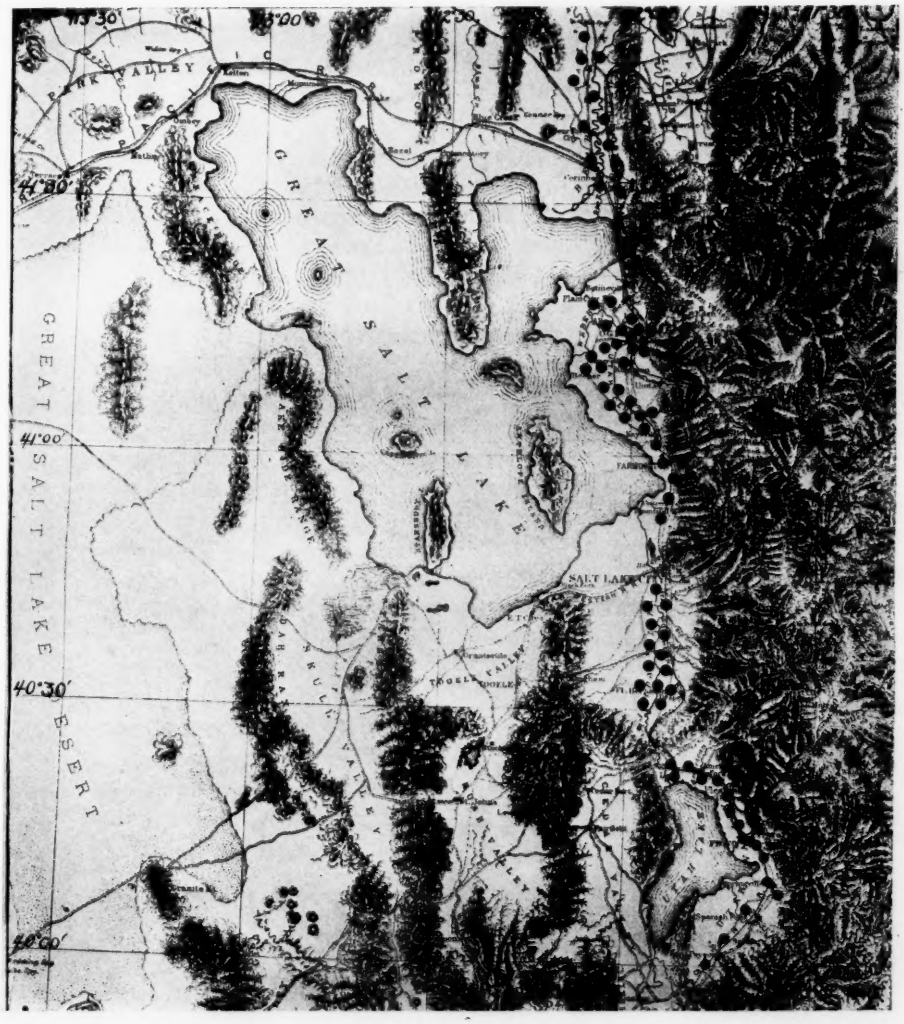
Hogs

A surprisingly small number of hogs are reared in the Salt Lake Oasis (fig. 31). In 1919 there were only 5.5 hogs per farm reporting swine in the five counties comprising the Oasis. It is not easy to account for the paucity of these animals, since excellent feed in the form of corn, alfalfa, wheat, barley, oats, sugar beets, and fruit is produced, and there is a good local market for pork and pork products. The farmers maintain that there is no money in swine. Dr. W. E. Carroll of the Utah Agricultural College says, "All conditions are favorable for the growth of swine, though some years ago the growing of hogs became so unprofitable that the farmers almost entirely discontinued to raise them." Probably the chief reason why so few are reared is that the majority of farmers live in towns and villages, where pig pens are a serious nuisance. Oftentimes, the number kept is too small to supply even the needs of the family. In some sections where swine are kept for home use, they are bought as pigs, raised, and butchered.

Swine production would be a profitable enterprise not only for dairy farmers but for others as well, because the Oasis offers a market for pork nearly as good as the district within 200 miles of Kansas City or Omaha.[88] "Only about 5 per cent of the hogs consumed locally are supplied by Utah, while approximately 100 cars pass through the state each week enroute to Pacific Coast cities."[89] More than 90 per cent of the hogs received in Salt Lake City are imported from adjoining states. About 160,000 swine were marketed by Nebraska alone through the Salt Lake Union Stockyards in 1923. Only 6,091 were marketed by Utah,

[88] Connor, L. G., *Op. cit.*, p. 30.

[89] Manderfield, J. H., Manager Salt Lake Union Stockyards, *Personal Communication.*



Scale, 23 miles per inch

FIG. 31. DISTRIBUTION OF SWINE IN 1919
Each dot = 500 swine

which state should furnish all the hogs handled in the Ogden and Salt Lake yards and those used by local packers. Manager F. W. Hoffman of the Cudahy plant at North Salt Lake says, "Although most of the cattle, calves, sheep and lambs handled by our plant come from the intermontane country, it is a deplorable fact that intermontane packers must go to eastern states for their supply of hogs. The Utah farmers have failed to interest themselves in the hog raising industry and as a result a tremendous revenue is lost to the state, which will increase with the years as the demands of the rapidly growing coast population increase. Out of a total of approximately 120,000 hogs slaughtered at Salt Lake and Ogden this year (1923), Utah furnished only 8000."[90] Furthermore, Utah should supply more hogs because they are needed to glean the beet, wheat, and barley fields, and to be finished on surplus grain.

Coöperative marketing is a comparatively recent feature connected with the hog industry. Shipping days are designated, cars of fat hogs are assembled from 10 or 20 farms, and the animals are shipped to market. The proceeds less actual expenses are turned over to the owners, and a gain is always realized over the prices of local buyers. Thus the farmer is encouraged to continue the business.

Poultry

Chickens are raised in considerable numbers in every Oasis county; there was a total of about 456,639 fowls in the region in 1919 (fig. 32). In 1923, however, the estimated number had increased to 1,081,246, of which 457,718 were in Utah County alone.[91,92] Climate, soil, feed, and market are the factors which

[90] Hoffman, F. W., *The Desert Evening News*, (Salt Lake City, December 15, 1923), p. 17.

[91] "Marketing Utah Eggs in New York," *The Utah Farmer* (Salt Lake City, July 28, 1923), p. 1.

[92] Professor Byron Alder, poultryman, Utah Agricultural College, in reply to a request regarding the reliability of the estimate of chickens in 1923 presented in the Utah Farmer under date of July 28, 1923, says, "There are no reliable data on the number of chickens in the region under consideration since the 1920 reports. The estimates given in the Utah Farmer may be slightly over drawn, yet the industry here has been coming up remarkably fast."

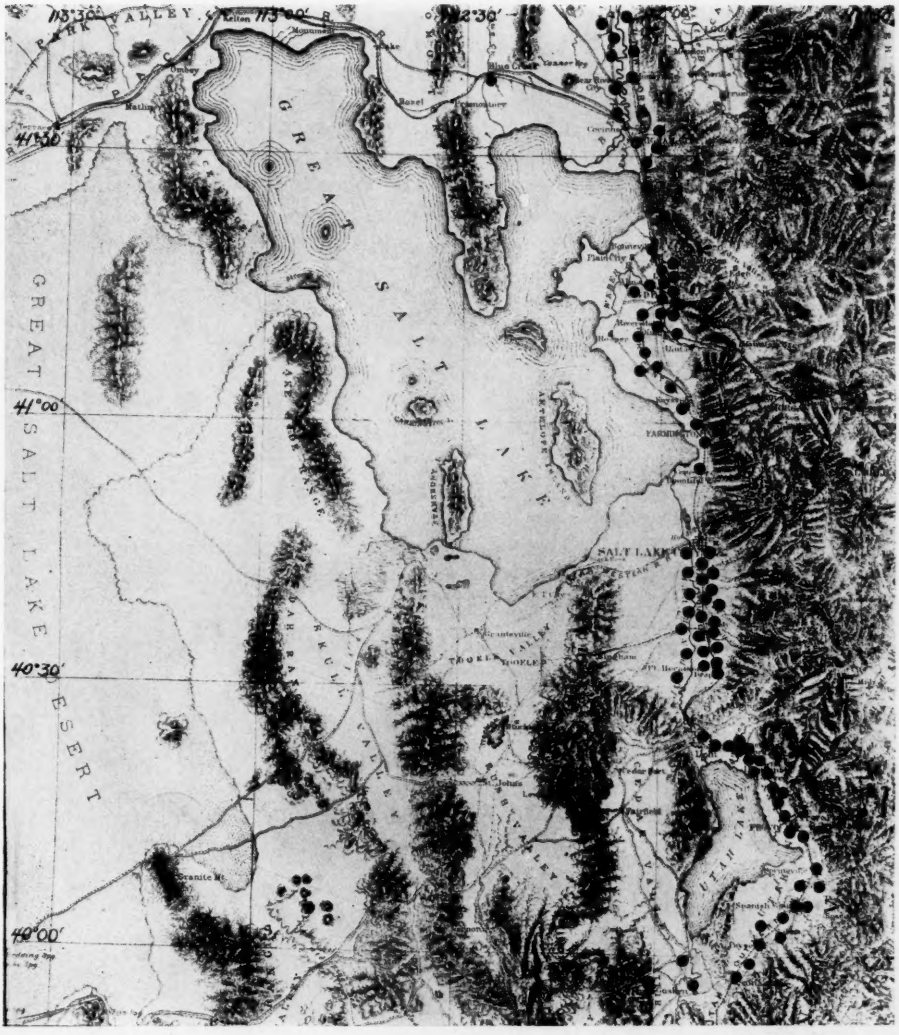


FIG. 32. DISTRIBUTION OF CHICKENS IN 1919
Each dot = 5,000 chickens

influence the poultry industry in the Oasis. Of these climate is probably most important because of its effect upon the cost of production and upon the health of the fowls. The most favorable conditions exist where the summers are not too hot nor the winters too cold, where there is a paucity of wind, and where the humidity is low. The dry pure air and the bright sunny days favor poultry production. Many of the diseases characteristic of eastern United States are little known here, and hence the annual egg production is about one and one-half dozen greater per hen than the average for the United States.[93]

Most of the commercial poultry farms are found on the well-drained bench lands which have southern exposures and comprise sandy and gravelly soils. Farms so located are favored by these conditions because the soil warms up early in the spring, and is "easily worked and kept sweet and free from disease-producing conditions."

The wide variety of soils in the region makes it possible to produce practically all kinds of poultry feed. Therefore it is not necessary to purchase expensive feeds from distant regions.

Utah Lake indirectly affects this industry. It is one of the largest fresh water bodies in the western half of the country and is a prolific breeding ground of carp and suckers. These fish, when properly cooked and prepared, make excellent chicken feed and stimulate egg production to a marked degree. The quality of the eggs is not affected unless fish are fed too heavily. Hence the Utah Lake district has become the center of the poultry business. During the winter season about 10,000 pounds of carp are removed from the lake daily, four-fifths of which are fed to chickens. The carp is carried by fish venders almost the entire length of the Oasis and distributed along the way.

The problem of selling his produce next confronted the poultry-farmer. Over production and comparatively sparse population in the intermontane region excluded any nearby market. In February, 1923, the Utah Poultry Producer's Association and its marketing agency, the Utah Poultry Producers, Inc. were

[93] Alder, Byron, "The Poultry Industry," *Statistics and Resources of Utah* (Salt Lake City, 1917), p. 112.

organized, with the result that they have completely revolutionized the chicken industry in the Oasis and in Utah generally. Through this channel, more than half the eggs handled are sent to New York City, where they are being favorably received, and are selling at prices ranging from one to three cents a dozen higher than the better grades of eggs from the Pacific Coast. The remainder of the first-class eggs are shipped to Los Angeles.

The conscientious grading done by the association is the foremost factor in the success of the business. A retailer receiving a case of these eggs finds them all uniform in size and color,

FIG. 33. WHITE LEGHORNS IN THE AMERICAN FORK DISTRICT

without dirt or cracks. Each case coming from the farm is numbered; the number and grade are recorded on an individual inspection strip.

The shipments out of the state are altogether of the top grades; the poorer eggs are sold locally to bakers and to other local buyers. The association books show that in May, 1923, the month of highest production, the lowest price paid to producers was 23 cents per dozen, whereas the price being paid at the same time by country store-keepers was from 8 to 10 cents. During the latter part of October, Oasis eggs on a full car were marketed

in New York at 75 cents for extras, 68 cents for firsts, and 50 cents for mediums. During the same time local store-keepers were paying 22 cents in trade.

This favorable situation naturally has created a new interest in poultry raising. Flocks varying in size from 500 to 10,000 chickens are not uncommon at American Fork, Lehi, Pleasant Grove, Spanish Fork, Draper, Sandy, Murray, Holliday, Ogden, Riverdale, North Ogden, and Brigham City.

The S. C. White Leghorn is the most popular breed throughout the region (fig. 33), because it is an excellent egg producer, is hardy, energetic, nervous, early maturing, and an excellent forager. It has only one handicap, its small size.

VIII. The Manufacture of Agricultural Products

The five Oasis counties, comprising about 11 per cent of the area of the state, were in 1919 responsible for 78.6 per cent of Utah's manufactured products based on value. It is probable, however, that the Oasis *per se*, comprising less than one per cent of Utah, contributed practically all of this amount. During that year Salt Lake City, Ogden, and Provo reported 33.8 per cent of the total value, and these cities carry on only a part of the sugar refining, smelting, canning, and milling of the Oasis.

The contribution of this region to the value of manufactured agricultural products is even more significant, because this geographic unit constitutes the garden spot of the arid intermontane wilderness. The Salt Lake Oasis can claim 12 of the 19 sugar factories, 34 of the 77 flour mills, 35 of the 38 canneries, 8 of the 12 cold storage plants, and 13 of the 22 creameries of the state. The geographic factors responsible for this concentration of factories are (1) high agricultural productivity, (2) cheap power, both coal and hydro-electric, (3) isolation from the large manufacturing sections of the country, making it necessary to convert surplus bulky food stuffs into concentrated forms for transportation to distant markets, and to work up certain materials into finished articles for home consumption, because of high freight rates, (4) dense population, 61 per cent of that of the state, (5) excellent transportation facilities, and (6) skilled labor.

HISTORICAL DEVELOPMENT OF MANUFACTURING IN UTAH

The Mormons have long been proficient in the utilization of native raw materials. They were driven by necessity in the early days to convert them into usable form, and were urged by their leaders to become independent of the outside world, as far as possible, by supplying their needs in home manufactories. Brigham Young's message to the legislature in 1852 is significant. He said, "Deplorable, indeed, must be the situation of that people whose sons are not trained in the practice of every avocation and whose daughers mingle not in the hive of industry. Produce what you consume; draw from the native elements the necessaries of life; permit no vitiated taste to lead you into indulgence of expensive luxuries which can only be obtained by involving yourselves in debt; let home industries produce every article of home consumption." This excellent advice was not unheeded; many small plants were erected. Manufacturing flourished, because within the region were raw material, power, market, and skilled labor. Here were some of Europe's best artisans, who had been proselyted by Mormon missionaries and brought to America from the great industrial centers of England, Germany, Holland, and Belgium.

It is interesting to note that succeeding Mormon presidents have emulated Brigham Young in advocating not only home manufactures but also the use of Utah-made products. At the 1918 Conference, President Heber J. Grant pleaded with the people "to be more loyal in sustaining and building up Utah manufacturing institutions."[94]

SUGAR REFINING

The Oasis is a pioneer in the beet sugar industry of the United States. In 1852 sugar machinery was purchased in Liverpool, shipped by way of New Orleans and the Mississippi and Missouri Rivers to Independence, and thence freighted overland to Salt Lake City where it was set up in a factory in Sugar House. This

[94] Grant, Heber J., "Home Manufacturers and Industries," *Utah, Your State* (Salt Lake City, 1918), pp. 1–3.

plant was not successful. In 1891 another establishment, the third to be operated successfully in the United States, was erected at Lehi. It has been enlarged three times and now has a capacity of 1400 tons of beets per day and makes about 30,000,000 pounds of sugar annually, or 30 times the amount produced in 1891.

Sugar factories, though distributed quite generally throughout the Oasis, are mostly in sections characterized by adequate water for irrigation, fertile well-drained soils, large comparatively level stretches of land, good roads, excellent railway facilities, and small farms. While the factories must be located relatively near the beet farms, at a distance not exceeding 30 or 40 miles, those of the Oasis are strung along the foot of the Wasatch at average intervals of about 11 miles. The result is a large number of mills in a restricted area, which is uneconomical from the point of view of the manufacturer because of too much competition. Until 1917, all the plants were operated by the Utah-Idaho and the Amalgamated Sugar Companies, and the distribution was excellent from a geographic and economic standpoint. When it became evident, however, that these companies were prospering several local establishments sprang up, with the result that now each finds it extremely difficult to contract for sufficient sugar beet acreage to operate profitably.

In 1923 the 12 Oasis factories[95] handled about 677,280 tons of beets from which they made 183,244,200 pounds of sugar valued at $13,285,204.

FLOUR MILLING

The history of flour milling in Utah has been one of progress and development. With the harvesting of the first field crops at Salt Lake in 1847, the immediate necessity arose for converting the grain into flour. Thus were called into existence the primitive grist-mills of the early days. Mountain streams were harnessed for power and mills were built wherever colonies were established. These simple plants, sufficient in number and capacity to supply

[95] Only 10 of these factories make sugar; the other two merely cut the beets.

the needs of the people, were the modest prelude to the eventual large scale development of milling in the whole intermontane country. Before the advent of the railroads, flour from the Oasis was hauled overland to supply the pioneer settlements in Idaho, Montana, and Nevada. It also fed those who were seeking El Dorado in the mushroom towns of the mining sections.

With the coming of the roller milling processes, plants of a larger size than the grist-mills were erected, and flour was exported on a large scale. When the advantages of location on railway lines became apparent and when these locations could not be readily found in conjunction with water power, steam was substituted in many plants. Later, the development of large hydro-electric generating stations, with consequent cheapening of power, supplanted steam in most of the larger plants of the region.

In the early days, Utah millers were handicapped in their efforts to compete in outside markets, owing to the mixture of hard and soft wheats. Now, however, this situation has become ameliorated, because the dry-farms grow chiefly Turkey Red, a hard variety, whereas the irrigated farms produce chiefly Dicklow, a soft type, so that the two varieties are kept distinct.

The Oasis contains 34 of Utah's 77 flour mills; Ogden claims 9 of these and Salt Lake 7; the remaining 18 are scattered genearlly throughout the region. Both Ogden and Salt Lake claim supremacy in the milling industry of the intermontane region. Ogden, however, is generally conceded this distinction, because of its better location with reference to wheat-producing areas, railways, and markets. This city, the hub of intermontane transportation, is the collecting and distributing center for northern Utah, the granary of the state, and for the important producing sections of southern Idaho. Several large modern plants have recently located in this city, chief of which are the Globe and Sperry Mills. Ogden's nine plants have a combined storage capacity of 2,500,000 bushels. Salt Lake City neither lies so close to important wheat producing areas nor does it have the excellent railway facilities of its northern neighbor.

CANNING

Dotting the agricultural landscape from Tremonton to Spanish Fork are 35 of Utah's 38 canning factories. From about September 4th to October 15th, the black smoke that pours from the chimneys of these conspicuous rural work-shops impresses one

TABLE 17

Total pack of fruits and vegetables—1922

COMMODITY PACKED	CASES						
	No. 1	No. 2	No. 2½	No. 10	Pints	½ Pints	Total
Apples				9,620			9,620
Apricots		810		40,244			41,054
Cherries		85	28,093	3,660			31,838
Peaches			166	7,665			7,831
Pears			1,090	1,957			3,047
Strawberries		892		717			1,609
Strawberry jam	1,604	1,098		277			2,979
Raspberries		187		98			285
Raspberry jam		459			119		578
Apricot jam		150					150
Miscellaneous jam			36				36
Gooseberries				60			60
Huckleberries				310			310
Tomatoes		141,296	590,505	47,328			779,129
Tomato pulp	2,500	400	40,105				43,005
Tomato catsup	2,700		5,853	33,465	20,411	2,431	64,860
String beans		48,637		6,549			55,186
Peas		726,185		15,204			741,389
Pumpkin		500	7,333	4,474			12,307
Hominy			3,700	90			3,790
Kraut		8,170	29,978	7,346			45,494
Corn		1,500					1,500
Pork and beans	7,600	9,600	6,900	125			24,225
Celery			204				204
Totals	14,404	939,969	713,963	179,189	20,530	2,431	1,870,486

* Courtesy Utah Canners' Association.

with the importance of this industry. The success of most of the truck farms is largely dependent on canning. Prior to the advent of this industry in 1888, the farms that now produce vegetables and fruits raised only wheat, alfalfa, and potatoes.

The geographic factors that determine the location of the canneries are: (1) proximity to vegetables and fruits, which in turn demand favorable climatic, relief, soil, and drainage conditions, (2) good roads, and (3) excellent railway facilities.

Fifteen of the thirty-five factories operate in the Ogden district, which is located on a large delta about 20 miles in diameter, and which commands a soil and climate ideally adapted to the growth of an especially fine type of tomato. Since these vegetables must be packed within 5 or 6 miles of a factory to avoid deterioration, this district, the tomato section of the state, is dotted with canneries. In 1923 it packed approximately one-half of the state's 2,500,000 cases of vegetables and fruits, and thereby became the chief canning center between Denver and the Pacific Coast.

Twenty-four varieties of fruits and vegetables were canned in Utah in 1922 totalling 1,870,486 cases, of which tomatoes and peas shared equally in the combined 1,520,518 cases. The total pack for that year is shown in table 17.

MEAT PACKING

The Utah meat packing business, concentrated at Salt Lake and Ogden, though of small proportions, is destined to become one of the leading industries of the state. No section of the intermontane region is so well located to carry on this pursuit as the Salt Lake Oasis, because it lies in the midst of a hinterland suitable only for grazing. Millions of head of sheep and cattle will be slaughtered annually in Salt Lake and Ogden, which occupy a focal position in this region, comparable to that of Chicago in the Middle West. Furthermore, the Oasis produces a surplus of alfalfa and grain which can be marketed most profitably through livestock, because of its high value per unit of weight. Here too, are the best transportation facilities in the intermontane West (fig. 34), which give access to admirable markets not very remote. The Pacific Coast cities, especially Los Angeles and San Francisco, will take all of Utah's surplus meat; hence it is to this market, rather than to far off eastern

cities, that Oasis stockmen and meat packers are looking. Utah, a great range state, lies nearer the Pacific Coast cities than do its competitors, Kansas, Nebraska, Colorado, Wyoming, and Idaho; it has, therefore, a decided advantage in the shorter haul. Its future as an important swine producer is also assured, inasmuch

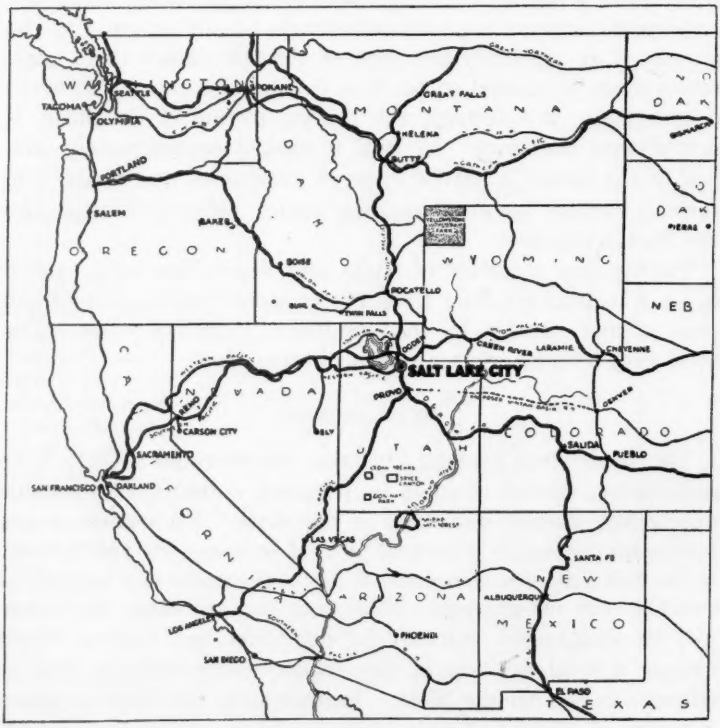


FIG. 34. THE STRATEGIC LOCATION OF OGDEN, SALT LAKE, AND PROVO AS COLLECTING AND DISTRIBUTING CENTERS IN THE INTERMONTANE REGION

as the farmers within the region now show a tendency to move into the country, increase the size of their farms, and thus alter the conditions which have retarded heretofore this branch of the livestock industry. While it is true that the Oasis is importing annually from the East, principally from Nebraska, about

112,000 of the 120,000 hogs slaughtered in Salt Lake City and Ogden, it is doubtful whether this practice will survive more than several years.

The two principal packing plants in Utah are the Cudahy at Salt Lake City and the American at Ogden. Each adjoins union stockyards, where hundreds of thousands of animals are handled annually; and they lie in a productive agricultural region whose active local markets are rendered accessible by ample rail facilities. The Cudahy Company increased its business 20 per cent in 1923, slaughtering 35,000 cattle, 60,000 hogs, and 45,000 sheep. The American Packing Company, owing to reorganization, showed no appreciable increase in 1923, but nevertheless slaughtered 18,000 cattle, 60,000 hogs, and 15,000 sheep.

BUTTER MAKING

The Oasis is characterized by centralized creameries which make butter in large plants, located at the transportation centers, Salt Lake and Ogden. Consequently 13 of Utah's 22 creameries are to be found within this geographic unit, 12 of which are in Salt Lake and Ogden. The factors which tend to concentrate these plants here are: (1) their central location in a productive feed region where dairying flourishes, and (2) excellent transportation facilities.

This industry though it manufactured only 3,703,528 pounds of butter in 1922, gives promise of expanding appreciably within the next few years, because of (1) the demand for butter in the cities on the Pacific Coast, (2) high acre yields of alfalfa, silage corn, and barley, (3) abundant wet beet pulp, an excellent cheap, succulent feed, (4) scarcity of tuberculosis among dairy cows, and (5) strategic commercial location in the basin province.

President E. G. Peterson of the Utah Agricultural College recently said "As information accumulates, it is being revealed that there are tremendous latent opportunities at our very doors. San Francisco, for instance ships from outside of the state 2,563,911 pounds of butter annually. Much of this comes from as far east as Illinois. Utah supplies only 136,326 pounds

of this 2,563,911 lot . . . Los Angeles imported in 1922 23,500,000 pounds of butter." These figures indicate the vast field open to the dairymen and creameries of the Oasis.

SUMMARY

While the industries discussed in this chapter consume the bulk of the surplus agricultural products of the Oasis, the candy, shoe, and biscuit factories, and the textile and saw mills have nevertheless a local importance and work up other raw materials of the state. The same principle underlies all these industries; surplus farm produce to be marketed profitably in distant marts, must be shipped in concentrated form.

IX. Commerce in Agricultural Products

The development of trade in Utah from the days of 1847, when probably the entire cash capital of the Mormons did not exceed $3000, till now, when the large commerce of the intermontane country is centered in the Oasis, presents some interesting and anomalous features. At first the Mormons desired to avoid all traffic with the outside world; but as emigrants passed through their settlements, they exchanged goods with them to mutual advantage. At home they traded by barter and the due-bill system. Until 1869 the Mormons had little use for money and preferred taking in exchange for their farm produce something they could eat, drink, or wear, and which they could not raise at home. Accordingly, scores of wealthy farmers seldom possessed a dollar in coin. This trade relationship was revolutionized by the advent of the Union Pacific in 1869, 22 years after the first settlement in Salt Lake Valley. This road made it evident that Salt Lake City and Ogden would become important commercial centers. Soon a struggle for commercial control between the Mormons and Gentiles began and is still in progress.

The Union Pacific thus brought to Zion a new and manifest destiny. It opened up to the people a wide market which by 1869 they desired vastly more than they had ever desired their secluded place of refuge. It introduced an interchange of goods with the East and the West.

Local railway lines, controlled by Mormon capital and built by Mormon labor, sprang up immediately. The Utah Central, operating between Ogden and Salt Lake City, was completed by January, 1870. The Utah Southern, running from Salt Lake City to Juab, 105 miles to the south, was opened for traffic in 1879. The Utah Northern, extending from Ogden to Franklin, Idaho, via Bear River and Cache Valleys, had reached Logan by January, 1873. A branch connecting Brigham City on the Utah Northern with Corinne on the Central Pacific, was completed in June, 1873. The Utah and Nevada, reaching west from Salt Lake City along the southern shore of Great Salt Lake, thence around the Oquirrhs and south across Tooele Valley, was begun in 1873. Branch lines of the Utah Central and the Utah Southern soon penetrated the mining camps of Bingham, Little Cottonwood, and American Fork Canyons, and for the first time in Utah history mining became important.

In 1883 the Denver and Rio Grande entered the Oasis southeast of Springville enroute to Ogden. This road conferred immediate benefit upon the Mormon settlements in Utah and Salt Lake Valleys. It reduced freight rates through competition and stimulated the development of nearby mineral resources.

The coming of the Los Angeles and Salt Lake in 1905 is regarded by Smythe as the most important single event in Utah history after the building of the Union Pacific, because it opened up a large mineral, agricultural, and stock region south of Salt Lake City and fostered the interchange of products between two contrasted agricultural regions—southern California and central Utah. It is an interesting and significant fact that the course of this typical piedmont road in a desert region was determined by the string of Mormon towns at the base of the Wasatch and San Pitch Mountains, which in turn were dependent on the streams that emerged from the mountains.

The Oregon Short Line and the Western Pacific are comparatively recent additions, as are the three interurban roads; each however, has played its part in the commercial development of the region.

COMMERCE OF TODAY IN RELATION TO GEOGRAPHY

The Oasis must dispose of its surplus agricultural products outside the sparsely settled intermontane region. Therefore, it must raise crops that have either high value per unit of weight or that can be converted into concentrated form for transportation to distant markets. This condition accounts for the manufacture of the commodities discussed in the preceding chapter.

The region, nevertheless, encounters difficulty in competing in eastern markets, because it has to pay the highest freight rate per mile of any section in the United States. For this reason the Utah farmer cannot market his agricultural products in the East as advantageously as the Pacific Coast rancher, despite the fact that he is 900 miles closer to his mart. This situation is attributable to low transcontinental and high intermediate rates imposed by the railroads in their effort to compete with steamships. Consequently the Mormon farmers are able to sell their fruits and vegetables at a profit only when the yield is below normal in the East; at all other times they either break even or lose. Obviously the Oasis has not yet found the ideal system of farming in relation to adverse discrimination in freight charges.

Refined sugar

The sugar beet, the chief cash crop of 75 per cent of the Oasis farmers, is refined within the region and moves to distant markets because of its high value per unit of bulk. Approximately 89 per cent of the sugar manufactured in 1923 was sold in distant markets with Chicago as the focal point. No other local industry depends to such an extent on distant markets and no other illustrates so clearly the limited extent of the intermontane market.

Canned goods

Approximately 60 per cent of the 2,500,000 cases of fruits and vegetables canned in the Oasis in 1923 was marketed outside the intermontane region. On this amount the canners realized no

profit. They gained only on the 40 per cent sold within the basin province.

A prominent official of the Utah Canners Association laid

TABLE 18*

Destination and number of cars of canned goods from the Ogden district during 1920

DESTINATION	NUMBER OF CARS
Arkansas	1
California	155
Colorado	64
District of Columbia	1
Idaho	46
Illinois	12
Indiana	3
Iowa	5
Kansas	4
Louisiana	1
Maine	1
Massachusetts	4
Michigan	2
Minnesota	2
Missouri	21
Montana	71
Nebraska	20
Nevada	3
New Mexico	3
New Jersey	28
Oklahoma	11
Oregon	31
Pennsylvania	13
South Dakota	2
Texas	52
Utah	59
Virginia	1
Washington	50
Wyoming	28
Total	694

* Utah Canners' Association.

the responsibility for the situation upon the railways which impose upon them such high freight rates. From each acre producing tomatoes for canning, he showed that the roads received

approximately $197.87. On this basis they realized $967,584.30 in transportation charges from the 4890 acres in tomatoes in 1923.

In 1920 the state shipped 778 cars of canned goods, 694 of which originated in the Ogden district. The distribution by states from this important canning center is shown in table 18.

TABLE 19*

Cars of livestock shipped from the Salt Lake Oasis January–December, 1918

DESTINATION	CALVES AND CATTLE	HOGS	SHEEP	HORSES AND MULES	MIXED	TOTAL
Chicago	2		101			103
Denver	417	3	121	3		544
E. St. Louis				3		3
Ft. Worth				7		7
Kansas City	304	1	1,650	2		1,957
Los Angeles	262	2	309	4		577
Ogden	510	65	277	33	9	894
Omaha	345	9	1,137	5	1	1,497
Portland	19	2	4			25
Pueblo			80	1		81
St. Joseph	19		173			192
Salt Lake City	366	108	893	8	20	1,395
San Francisco			162			162
Spokane			2			2
Tacoma	8					8
Canada				1		1
Various	733	29	5,060	118	12	5,952
Totals	2,985	219	9,969	185	42	13.400

* Courtesy Bureau of Agricultural Economics.

Flour

About 80 per cent of the flour manufactured in the Oasis is exported to two contrasted deficient regions, the Cotton Belt and California. In 1924 practically the entire amount was shipped to the latter region; in former years, however, at least 75 per cent of the surplus flowed to the former region. The soft wheat flour is preferred in the South, where it is converted into hot bread and biscuits. The hard wheat flour is in demand in California because it makes better pastries and cold bread. The nice adjustment of marketing to production is therefore evident,

for the Oasis, owing to natural conditions, raises the hard varieties on the dry-farmed benches and the soft types on the irrigated plain.

Livestock and meat products

Whereas the bulk of the livestock of the region moves East, most of the meat products move West. Livestock shipments from the Oasis in 1918 amounted to 13,400 cars, divided as follows: cattle and calves 2985; hogs 219; sheep 9969; horses and mules 185; and mixed 42. These were distributed in the following livestock markets (table 19). No data are available for meat products for 1918, though for 1922 "railroad shipments originating in Utah totaled 528 cars of fresh meats and 78 cars of other packing house products."[96]

Eggs

The Oasis exported 9 cars of eggs in 1922 and 175 in 1923. This phenomenal increase took place because of the formation of the Utah Poultry Producers' Coöperative Association, which stimulated the commercial poultry business by creating a sure market for first class eggs in New York and Los Angeles.

Vegetables

The Oasis shipped approximately 72 per cent of Utah's 476 cars of potatoes in 1920. This is only a fraction of what it might export if a satisfactory profit could be realized; but ordinarily, owing to high freight charges, the Oasis crop admits a profit only on the choice varieties, especially those suited to baking. The transportation costs from the Oasis to Chicago on the yield from an acre planted with potatoes are about six times as great as those from an equal area devoted to sugar beets. During some years tubers bring so poor a price that it does not pay to harvest them. The potato as a money crop is being rapidly replaced by sugar beets and alfalfa, and even by corn in some sections.

Other vegetables, especially Spanish onions, tomatoes, and head

[96] Justin, M. M., State Statistician.

lettuce, are shipped in considerable amounts; during 1922, 625 cars of fresh vegetables were sent East from this region.

Fruit

The outstanding fact in Oasis fruit culture is the dependence of a large proportion of the farmers on a distant and uncertain market for the disposal of their crop. This has been especially pronounced during the past decade, owing to the marked increase in the acreage devoted to fruit. A notable percentage of the peach growers operate small farms, which average less than 18 acres in Utah Lake Valley. Their dependence on fruit is not safe, because they have to compete in the Chicago mart with the Michigan fruit grower, whose production and market costs are appreciably less.

Despite high freight rates, hundreds of cars of fruit are shipped from the region annually. In 1920, 91 per cent of the 984 cars of apples, peaches and pears exported from Utah, originated in the Oasis.

SUMMARY

This survey of commerce in Oasis agricultural products proves conclusively that, since the local markets are limited and the distant ones uncertain, less dependence should be placed on the growing of bulky and perishable fruits and vegetables other than for canning. The solution of the problem, however, is not easily reached, because the natural conditions give rise to an unavoidable dilemma. It will be difficult to make either an extensive or an intensive form of agriculture successful in this region, because the latter demands a larger and more accessible market than is available, and the former needs cheaper land than is to be had. It is plain that on the whole a fairly extensive type embodying staple crops must prevail, for the time is not ripe for an extension of the highly intensive form of agriculture.

Conclusions

The Salt Lake Oasis in wealth, population, and stage of development is the capital of the intermontane country. Originally

one of the most barren spots in the Western wilderness, this region has become as fruitful a region as exists anywhere in the United States. With the unkindly soil, the extremes of temperature, the paucity and uncertainty of the rainfall, the lack of trees, except such as grew here and there in narrow, rock-ribbed gorges, with fuel almost inaccessible at points where habitation was possible, and with no near neighbors,—amid this repellent and inhospitable region, the Mormons made their busy settlements. As time progressed they transformed these barren solitudes into a country teeming with industry.

It has been the purpose of this study to show in what ways and to what extent the activities of the people, in so far as they pertain to agriculture, have been affected primarily by geographic conditions and secondarily, by economic, and social factors. In this connection the more significant conclusions are:

1. That the Salt Lake Oasis is a distinct geographic unit because of its homogeneity in natural environment and in the resulting economic and social activities.

2. That the Oasis, because of better water supply, soils, transportation facilities, and markets, contains approximately 64 per cent of the farming population of Utah, though it comprises less than one per cent of the area of the state.

3. That the highly developed agriculture in the region depends almost entirely upon the irrigation water derived from the mountains to the east and that the crops produced, the animals reared, and the systems of farming followed are intimately related to the natural environment.

4. That the large majority of the farms in the oldest sections, especially those near Salt Lake City, Ogden, and Provo, are too small to maintain the American standard of living. They are approaching the standards of northwestern Europe, especially France.

5. That Oasis farms are small because of:

a. The early land system adopted by the Mormon leaders

b. The subdivision of many farms among the children, who remain at home in order to retain their Church affiliations

c. The high cost of the land, water rights, and improvements

d. The small amount of arable land available in proportion to the population.

6. That the small size of the farms has encouraged the development of intensive tillage under irrigation; that small farms and large families have necessitated reliance on crops which give high per acre returns and which can be marketed locally; that some members of large families have to seek outside employment owing to the small labor income derived from the miniature farms.

7. That the town-dwelling habit characterizing most of the Oasis farmers has its advantages and disadvantages with the balance against the practice.

Advantages	*Disadvantages*
a. Better schools	*a.* Discourages animal industries
b. More conveniences	*b.* Necessitates the loss of much time in travel from town to farm
c. Enhanced social opportunities	*c.* Reduces to a minimum home gardening

8. That grain farming on the valuable irrigated lands will steadily give way to sugar beet and alfalfa growing, dairying, truck-farming, and general stock-rearing; that grain farming will become increasingly important on the cheaper dry-farmed benches.

9. That dependence on truck farming and peach growing is economically unsound, because agricultural areas developed at such high costs are severely handicapped in competing with cheaper lands equally productive but closer to the great markets of the country.

10. That more cattle, hogs, sheep, and poultry should be reared on farms within the Oasis, because these animals could consume the bulky feeds, yield products with higher value per unit of weight, and furnish the manure so necessary to the permanency of agriculture in any region.

11. That the systems of farming are often determined by sugar factories and canneries, which control many irrigation canals.

12. That the bulk of the surplus agricultural products, in order to be marketed profitably, must be exported in concentrated forms, characterized by their higher value per unit of weight.

13. That the successful marketing of Oasis agricultural products will depend in a large measure upon the organization and development of coöperative systems of marketing.

14. That there is a tendency to increase the scale of Oasis farm operations by:

a. Grazing sheep and cattle on the desert and forest pastures

b. Raising grain on the bench lands under dry farming methods

c. Renting additional land; this will necessitate the consolidation of holdings and the consequent removal of many farmers to cities.

15. That the tilled area will increase appreciably as artificial drainage and better methods of utilizing the water supply are inaugurated, and as marketing facilities become enhanced.

16. That the Ogden district is the center of the canning industry because:

a. It has excellent transportation facilities

b. It is located on a large delta with a long growing season and fertile soils, both of which favor the growth of tomatoes, and make this the great producing center of the Oasis.

c. The factories must be located at intervals not exceeding five or six miles because of the perishable nature of tomatoes, which prevents their being hauled long distances by wagon or truck.

17. That the old pioneer irrigation systems, which are responsible for waste of much water through evaporation and seepage, should be demolished and replaced by new scientifically planned works as soon as practicable; that reservoirs should be constructed to conserve the spring flood waters of the rivers.

18. That floods can best be avoided in the Oasis by restricting the grazing of sheep in the nearby canyons.

19. That success with either an extensive or an intensive form of tillage is difficult to attain in the Oasis, because the one needs cheaper land than the region offers, whereas the other demands a larger and more accessible market than is at present available. That a fairly extensive type embodying staple crops must prevail, because the time is not ripe for an intensive form of agriculture.

20. That the Mormon Church enforced a system of agriculture

and of land holdings which was admirably suited to the natural environment of the Oasis and to the needs of a young and small settlement, but which revealed serious limitations when population increased and large-scale agricultural enterprises became imperative.

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